The Welding Engineer

Reg. U. S. Pat. Office

Founded by L. B. Mackenzie, 1916

FEBRUARY, 1929 VOL. 14, NO. 2

$3.00 per year in U. S. 606 S. Dearborn St., Chicago, Ill. $4.00 per year abroad

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Published monthly by the Welding Engineer Publishing Co. Entered as second class matter Jan. 10, 1916, at the Post Office at Chicago, Ill., under the Act of March 3, 1879.

use STOODITE *where metal wears*

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Write Dept. 3 for a complete description of STOODITE the super-hard facing metal.

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Manufacturers of

WELDING ROD • ALLOY STEELS • EQUIPMENT

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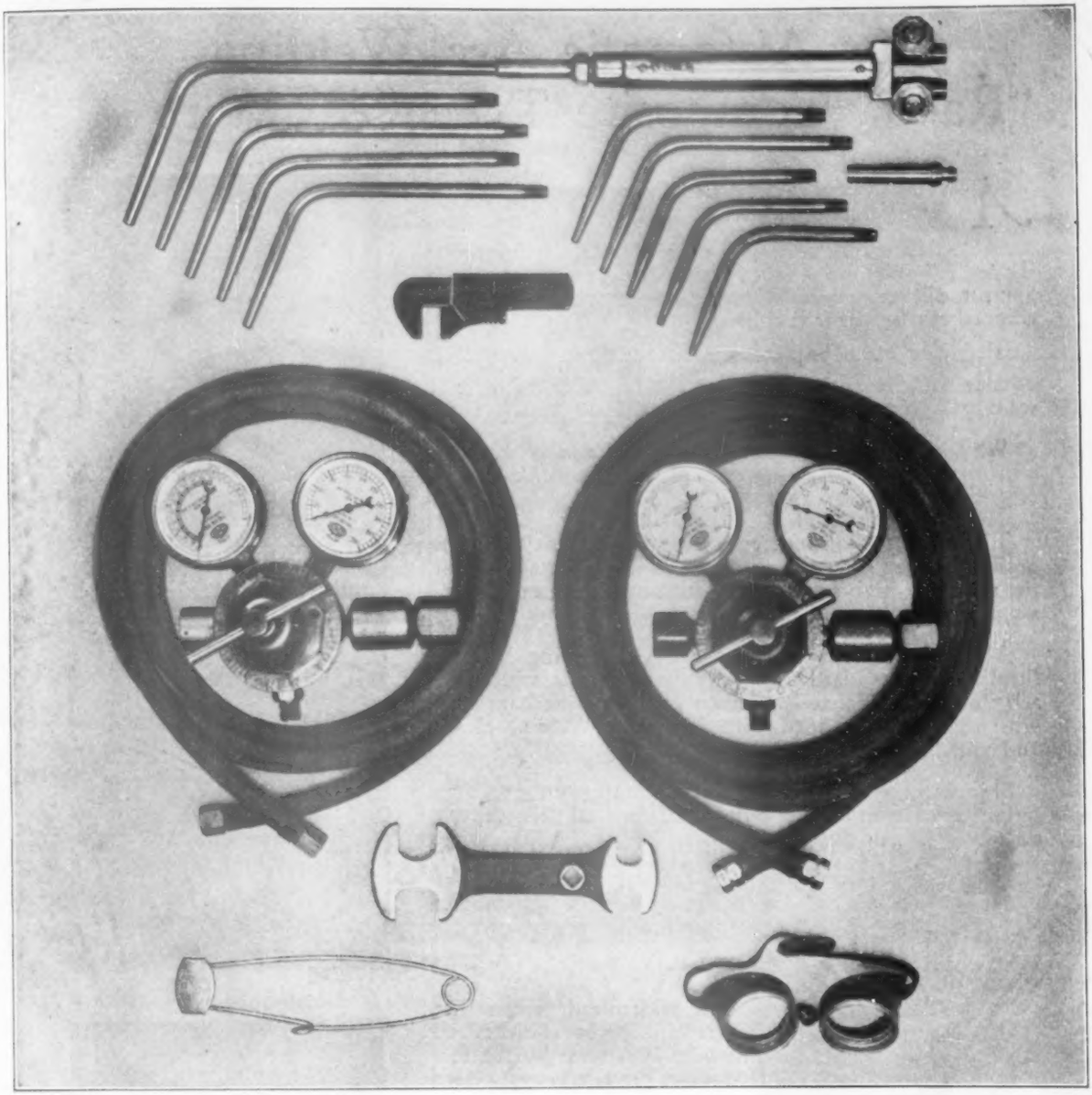

An Airco-Davis-Bournonville General Welding Outfit

This general purpose oxyacetylene welding outfit meets the requirements of the small welding shop and of the largest industrial plant, for repairs, maintenance, manufacturing, or construction work, and for light, medium, or heavy welding. It combines the highest welding efficiency obtainable with simplicity, interchangeability, sturdy construction, economical gas consumption, and low cost of upkeep.

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A WIRE specially developed for use with automatic Arc Welding machines.

The outstanding feature of "Raco" Composite Type "A" Wire is a series of lengthwise grooves containing a most efficient arc stabilizing material which cannot be chipped out by the feed rollers.

A perfect contact is insured due to the absence of flux on outside of wire and also due to the fact that the wire is solid rather than made up of several units.

We are able to guarantee highest possible speed, absolute uniformity and arc stability with the finest possible quality of welds.

The prices are considerably lower than is usual on wires ordinarily used for Automatic Arc Welding on account of the relatively high speed with which our continuous process produces our finished product.

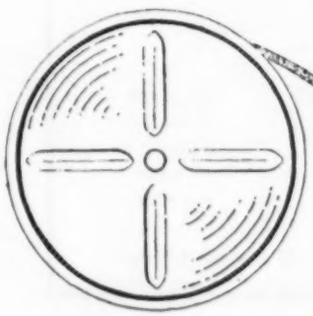
All "Raco" Composite Type "A" Welding Wire is furnished in standard compactly wound coils which exactly fit our special reels. These reels are interchangeable with reels generally used with Automatic Welding Heads and will fit present mountings.

Shipping the wire in coils saves incoming and outgoing freight on a considerable number of reels also the deposit on reels while in customer's hands.

One special reel at nominal cost is needed for each automatic welding head in operation.

The widespread success that has rewarded the efficiency of this wire is attested by the fact that today practically every large installation of automatic arc welding machines in the country is using "Raco" Composite Type "A" Wire.

If you will advise us what size wire you are using at the present time we will be happy to forward you samples for test purposes—all charges prepaid—and quote you prices.



REID-AVERY CO., Inc.

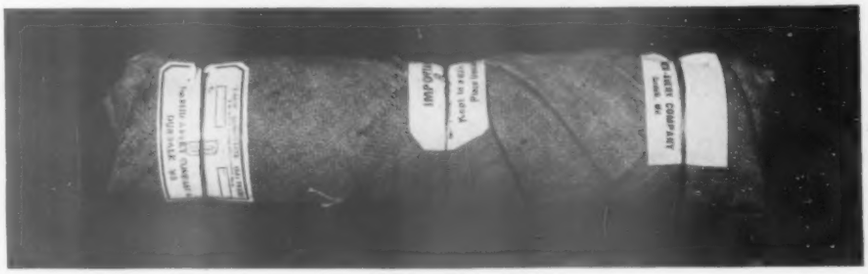
21st and Washington Avenue Philadelphia, Penna.

Works: Baltimore, Md.

Announcing the New

"Raco" Composite Type "B" Electrode

for Manual Welding



THIS Electrode is of standard .13 to .18% carbon analyses and each rod has lengthwise grooves rolled into its entire length. These grooves are filled with a remarkable arc stabilizing agent. Due to its construction we are able to guarantee absolute uniformity with no rejections from any cause whatsoever. *This electrode has splendid penetration and high welding speed in addition to absolute uniformity.* We do not believe that uniformly satisfactory results can be obtained over a period of time with a bare electrode, and Raco Composite Type "B" Wire has been perfected with a view of getting away from inequalities of bare wire. The arc stability of this new wire is so perfect that it may be used with equal success with either D.C. or A.C. current where Flux Coated Electrodes have been considered necessary. The cost of this electrode is no more than a good grade of bare wire and means absolute satisfaction. It is the most reliable electrode on the market for straight production use.

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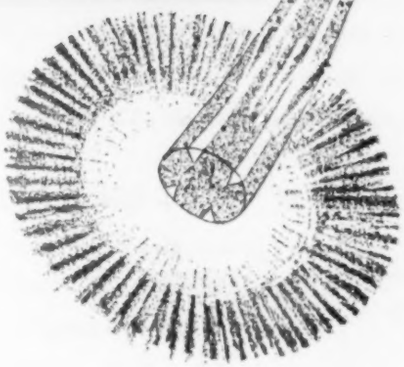
In addition to the rods mentioned above are "Raco" .95 — 1.10 high carbon rods and "Raco" 3½ percent nickel steel rods.

Samples of any of these rods will be cheerfully furnished on request, charges prepaid. Please advise sizes desired.

DEALERS ATTENTION: We have at present a most attractive proposition in some very desirable territory. Write us at once.

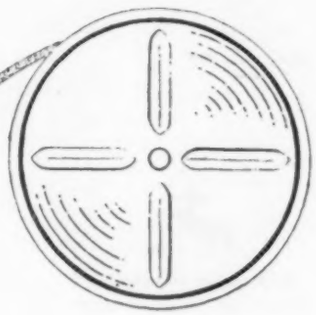


A large and complete stock of all grades of Raco Welding Wires is carried in Los Angeles, California and prompt shipments can be made from this stock. M. E. Canfield Company, Pacific Coast Representatives, 316 Commercial Street, Los Angeles, California.

REID-AVERY CO., Inc.

21st and Washington Avenue Philadelphia, Penna.

Works: Baltimore, Md.



YOU CAN PLACE YOUR FAITH IN CHASE WELDING RODS—AND CHASE SERVICE

The Mark that Identifies Good Brass and Copper Products

You expect certain definite qualities in a *good* welding rod. It must be strong and close grained . . . it must melt easily and flow freely . . . it must machine easily and take a high finish if desired . . .

You'll find that Chase Welding Rod will meet the requirements of the job you have in hand. Chase Welding Rod — in Bronze †, Manganese and Brass — are Chase products that are carefully made and sold with a guarantee of satisfaction.

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† *Chase Chāmet Bronze Welding Rod is made from our own particular mixture of bronze, which we have named Chāmet to distinguish it from ordinary kinds of bronze. Details of tensile strength, elasticity and machining properties gladly mailed upon request.*

CHASE WELDING RODS

Chase Chāmet Bronze Welding Rod
Chase Manganese Welding Rod
Chase Brass Welding Rod

The Mark that Identifies Good Brass and Copper Products

The Mark that Identifies Good Brass and Copper Products

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The Welding Engineer

Founded by L. B. Mackenzie, 1916

Volume 14 | February, 1929 | Number 2

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Good Will and the Buyer

MANY purchasing agents have learned from experience that there are many satisfactions resulting from dealing with salesmen who make it a point to build good will. Business transactions have a way of meeting unexpected obstacles at the most inopportune time. These often give the seller an opportunity to do more than the contract specifies. A spirit of friendship, or of mutual respect, between buyer and seller makes the purchaser feel comfortable regarding such developments in connection with a purchase. So it is natural for a thoughtful buyer to favor with his orders the firms who enjoy the capacity for building good will. Since the standard way of building good will is the combination of advertising backed by quality and service, the buyer has little difficulty in locating the most desirable sources. Advertising to lay the foundation for good will may seem to be a selfish policy in some respects, but few people realize how much the man who spends the money appreciates this guide to his best market.

Published on the 15th of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,
608 S. Dearborn St., Chicago, Ill.
Telephone Wabash 7134

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Western Office—1244 Harper Ave., Los Angeles, Cal. Miles C. Smith, Western Manager.

Subscription payable in advance and postage free.
United States and possessions and Canada ..... $3 a year
Foreign Countries ..... $4 a year
Single copy, domestic ..... 35 cents
Single copy, foreign ..... 30 cents

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

The Welding Engineer is a member of the Audit Bureau of Circulations and of the Associated Business Papers, Inc.

Last Advertising forms close at 8:00 a. m. on the 12th. To show proof for correction copy must be received at an earlier date and allowances should be made for delay to mails. All copy should be in by the 12th of the month at the latest.

The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Air Reduction Sales Co.
Commercial Acetylene Supply Co.
International Oxygen Co.
Prest-O-Lite Co.
Superior Oxy-Acetylene Co.

ACETYLENE CYLINDERS
Pressed Steel Tank Co.

AIR LIQUEFACTION OXYGEN PRODUCING PLANTS
Keith Dunham Company
Heylandt Sales Co.

ALUMINO-THERMIC WELDING
Metal & Thermit Corporation

ALUMINUM SOLDER
Crown Aluminum Solder Co.
Reynolds Metals Co.

ANNEALING FURNACES
General Electric Co.
Westinghouse Elec. & Mfg. Co.

APRONS (Asbestos)
Ideal Face Shield Co.

ASBESTOS INSULATED WIRE AND CABLE
Central Steel & Wire Co.

BLOW PIPES
See "Torches."

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Lincoln Electric Co.
Linde Air Products Co.
Electric Arc Cutting & Welding Co.
Larry Sherman & Co.

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Bastian-Blessing Co.
Craftsweld Equipment Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Alexander Milburn Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Co.
Torchweld Equipment Co.
Victor Oxy-Acetylene Equipment Co.
Williams & Co.

BRONZE FILLER RODS
American Brass Co.
Central Steel & Wire Co.
Chase Brass and Copper Co., Inc.
Mueller Brass Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Co.
Steel Sales Corp.

BUFFERS
Blax Flexible Shaft Co.
R. G. Haskins Co.
N. A. Strand & Co.

BUTT WELDERS
See "Electric Resistance Welders"

CABLE (Arc Welding)
Allan Mfg. & Welding Co.
Central Steel & Wire Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Lincoln Electric Co.
Quasi-Arc Weldtrode Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

CARBIDE
Air Reduction Sales Co.
National Carbide Co.
Shawinigan Products Corp.
Superior Oxy-Acetylene Co.
Union Carbide Sales Co.

CARBON (Blocks, Paste, Electrodes, etc.)
Air Reduction Sales Co.
Central Steel & Wire Co.
Electric Arc Cutting & Welding Co.
National Carbon Co.
Oxweld Acetylene Co.

CARBON BURNING EQUIPMENT
Air Reduction Sales Co.
Bastian-Blessing Co.
Craftsweld Equipment Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Co.
Torchweld Equipment Co.
Victor Oxy-Acetylene Equipment Co.

CAST IRON SOLDER
Crown Aluminum Solder Co.
Superior Oxy-Acetylene Co.
Weldene Corporation

CAUSTIC POTASH
Innis, Speiden & Company

CUTTING ELECTRODES (Electric Arc)
Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
Lincoln Electric Co.
National Carbon Co.
Westinghouse Elec. & Mfg. Co.
Wilson Welder & Metals Co.

CYLINDERS (Acetylene)
Pressed Steel Tank Co.

CYLINDERS (Oxygen, Hydrogen)
Chas. L. Gulick.
Wm. Wharton, Jr. Co.
Harrisburg Pipe & Pipe Bending Co.

DRILLS, PORTABLE ELECTRIC
Blax Flexible Shaft Co.
R. G. Haskins Co.
Stoody Company
N. A. Strand & Co.

ELECTRIC ARC WELDING OUTFITS
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Burke Electric Co.
Chicago Steel & Wire Co.
Electric Arc Cutting & Welding Co.
Electric Welding Machine Co.
Fusion Welding Corporation
General Electric Co.
Goodman Electric Machinery Co.
Gibb Welding Machines Co.
Hobart Bros. Co.
C. H. Hollup Corp.
Lincoln Electric Co.
E. A. Lundy Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Incorporated
Stoody Co.
Superior Oxy-Acetylene Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRIC RESISTANCE WELDERS
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General Electric Co.
Gibb Welding Machines Co.
Goodman Electric Machinery Co.

ELECTRODES (Carbon Arc Welding)
See "Cutting Electrodes"

ELECTRODES (Metallic Arc Welding)
American Steel & Wire Co.
Atlas Foundry Co.
Central Steel & Wire Co.
Chicago Steel & Wire Co.
Electric Arc Cutting & Welding Co.
Fusion Welding Corporation
General Electric Co.
Gibb Welding Machines Co.
E. D. Giberson & Co.
C. H. Hollup Corporation
Koro Corporation
Lincoln Electric Co.
Page Steel & Wire Co.
Quasi-Arc Incorporated
Reid-Avery Co.
Roebling, John A., Sons Co.
Seneca Wire Mfg. Co.
Standard Steel & Wire Co.
Steel Sales Corp.
Stoody Company
Wickwire Spencer Steel Corp.
Williams & Co.
Wilson Welder & Metals Co.

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Allan Mfg. & Welding Co.
Burke Electric Co.
Chicago Steel & Wire Co.
Electric Welding Machine Co.
Fibre-Metal Products Co.
Fusion Welding Corporation
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Koro Corporation.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Stoody Co.
Superior Oxy-Acetylene Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRODE TIPS (Resistance Welding)
Elkon, Inc.

ELECTROLYTIC OXYGEN AND HYDROGEN GENERATING EQUIPMENT
International Oxygen Co.

FACE SHIELDS (Arc Welding)
Allan Mfg. Co. & Welding Co.
American Optical Co.
Burke Electric Co.
Central Steel & Wire Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Fibre-Metal Products Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Incorporated
Stoody Company
Superior Oxy-Acetylene Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.
Wilson Goggles, Inc.

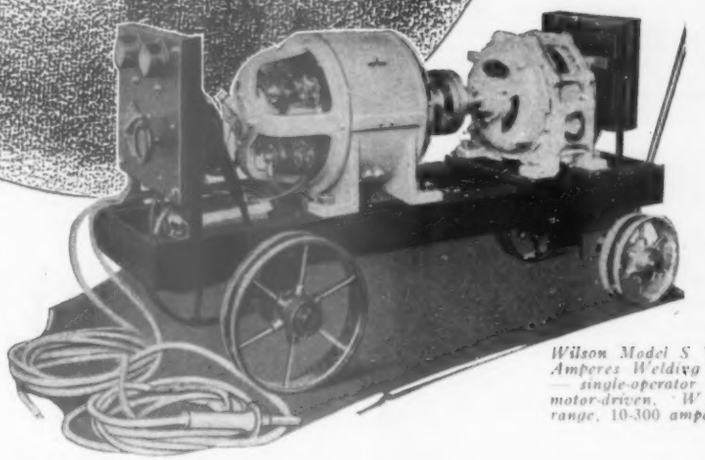
FILLER RODS
Air Reduction Sales Co.
American Brass Co.
American Steel & Wire Co.
Atlas Foundry Co.
Central Steel & Wire Co.
Craftsweld Equipment Co.
Fusion Welding Corporation
E. D. Giberson & Co.
C. H. Hollup Corp.
Imperial Brass Mfg. Co.
Mueller Brass Co.
Koro Corporation
Oxweld Acetylene Co.
Page Steel & Wire Co.
Reid-Avery Co.
Roebling, John A., Sons Co.
Seneca Wire Mfg. Co.
St. Paul Welding & Mfg. Co.
Standard Steel & Wire Co.
Steel Sales Corp.
Stoody Co.
Superior Oxy-Acetylene Co.
Torchweld Equipment Co.
Wickwire Spencer Steel Corp.
Weldit Acetylene Co.
Williams & Co.

FIREPROOF PLASTIC MATERIAL
Air Reduction Sales Co.
National Carbon Co.

FLUE WELDERS (Electric)
General Electric Co.

FLUXES
Air Reduction Sales Co.
Anti-Borax Compound Co.
Metal & Thermit Corp.
Central Steel & Wire Co.
Modern Engineering Co.
Oxweld Acetylene Co.
St. Paul Welding & Mfg. Co.

TODAY from *Every Part of the Globe*



Wilson Model S Type 200 Amperes Welding Machine — single-operator electric-motor-driven. Welding range, 10-300 amperes.

comes the demand for WILSON Machines and Wire

THE world has *discovered* the superiority of the electric arc—its adaptability, its efficiency — in making strong, homogeneous welds.

Today, from every continent, from almost every nation, comes the demand for Wilson Machines and Wire—expressing *world-wide* recognition of the unparalleled efficiency of the *Wilson* electric weld. Pioneers in electric welding, Wilson offers to you its long and varied experience —its great accumulation of welding information—without obligation.

Trade Mark Reg. U. S. Pat. Off.

Questions are invited. Write for illustrated bulletins, describing Wilson Model S Machines. Also ask for samples of Wilson "Color-tipt" Welding Wire—indicating the kind of metal that you desire to weld.

WILSON WELDER & METALS CO. INC., 20 WILSON BUILDING, HOBOKEN, N. J.

WILSON

WELDING MACHINES AND WELDING WIRE

Superior Oxy-Acetylene Co.
Torchweld Equipment Co.
Weldit Acetylene Co.

GAS SAVING DEVICES
Weldit Acetylene Co.

GLOVES (Asbestos)
Ideal Face Shield Co.

GAUGES
Moto Meter Co.
National Gauge & Equipment Co.

GENERATORS (Acetylene)
Air Reduction Sales Co.
Bastian-Blessing Co.
Craftsweld Equipment Co.
Imperial Brass Mfg. Co.
Milburn, Alexander Co.
Modern Engineering Co.
Oxweld Acetylene Co.

GLOVES
Morrison-Ricker Mfg. Co.

GOGGLES
American Optical Co.
Chicago Eye Shield Co.
Ideal Face Shield Co.
Willson Products, Inc.

GRINDERS (Portable Electric)
Biax Flexible Shaft Co.
R. G. Haskins Co.
Stoody Company.
N. A. Strand & Co.

HELMETS (Arc Welding)
Allan Mfg. & Welding Co.
American Optical Co.
Burke Electric Co.
Central Steel & Wire Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Fibre-Metal Products Co.
Fusion Welding Corporation
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Incorporated
Superior Oxy-Acetylene Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.
Willson Products, Inc.

HYDROGEN
Gas Products Association
International Oxygen Co.

HYDROGEN GENERATING PLANTS
International Oxygen Co.

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Air Reduction Sales Co.
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Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Modern Engineering Co.
Milburn, Alexander, Co.
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Superior Oxy-Acetylene Co.
Torchweld Equipment Co.
Victor Oxy-Acetylene Equipment Co.
Weldit Acetylene Co.

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Oxweld Acetylene Co.
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Shoot-a-Lite Corporation.
Superior Oxy-Acetylene Co.
Torchweld Equipment Co.

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Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Co.
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MECHANICALLY OPERATED CUTTING AND WELDING TORCHES
Air Reduction Sales Co.
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Torchweld Equipment Co.

MOLDING MATERIAL
See "Fire Proof Plastic Material"

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Bastian-Blessing Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.
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Gas Products Association
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OXYGEN
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Electric Arc Cutting & Welding Co.
Hobart Bros. Co.
Lincoln Electric Co.
Northwestern Mfg. Co.
Wilson Welder & Metals Co.
Westinghouse Electric & Mfg. Co.
Shrader Electric Company

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Imperial Brass Mfg. Co.
Metal & Thermit Corp.
St. Paul Welding & Mfg. Co.

REAMERS (Portable Electric)
R. G. Haskins Co.
N. A. Strand & Co.

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Bastian-Blessing Co.
Craftsweld Equipment Co.
Fusion Welding Corporation
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International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
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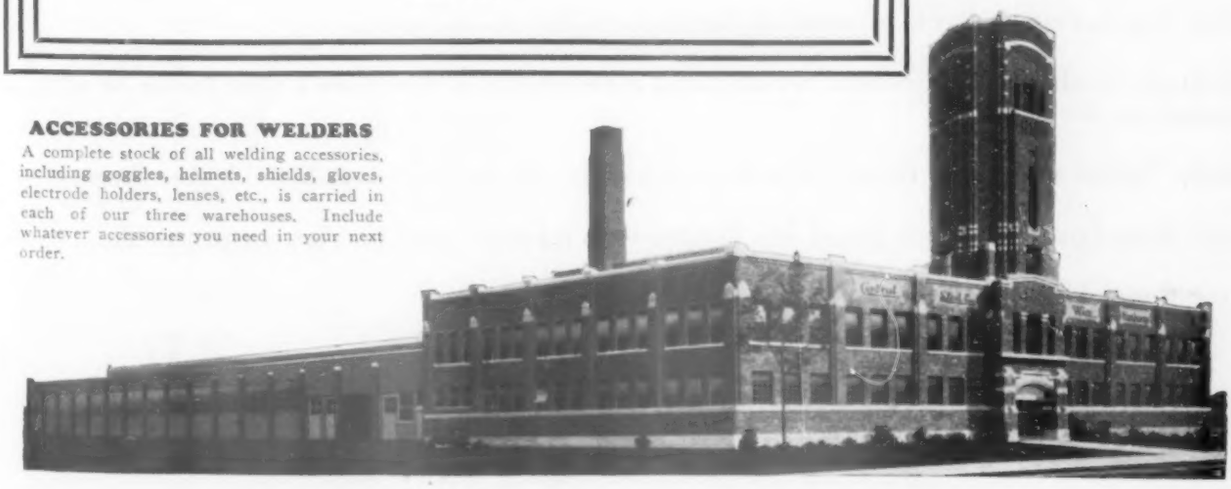

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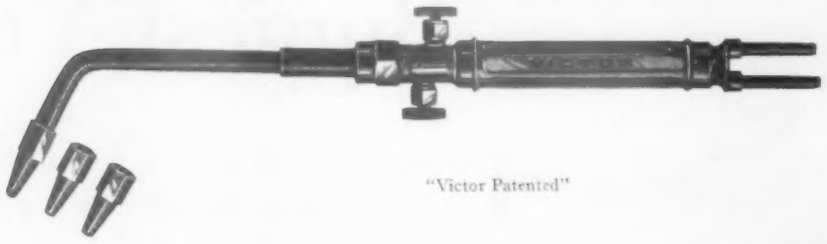

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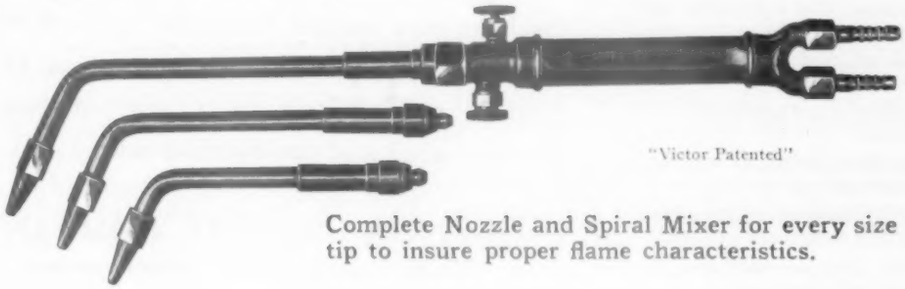

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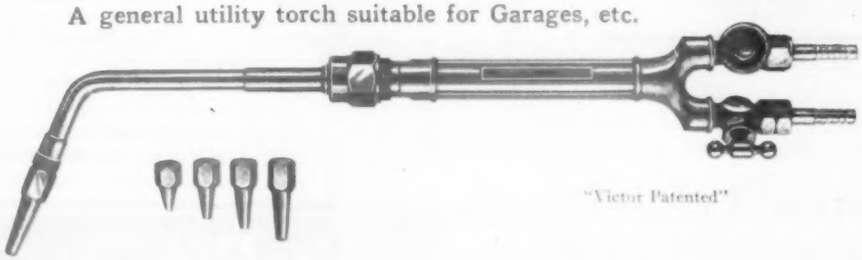

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Because of that we had to drop your proposal for a Lincoln 'Stable-Arc' machine although we had a perfectly open mind when we approached the subject."

"Yes, Pop—

and you got a welder that just approaches the 'Lincoln.'

The board realized that we have a lagging business and arc welding looks like the way to speed it up.

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That's why I suggested Lincoln—because they started arc welding, developed it, specialize in it, give you a machine with features (see panel) that produce more and better welding per day.

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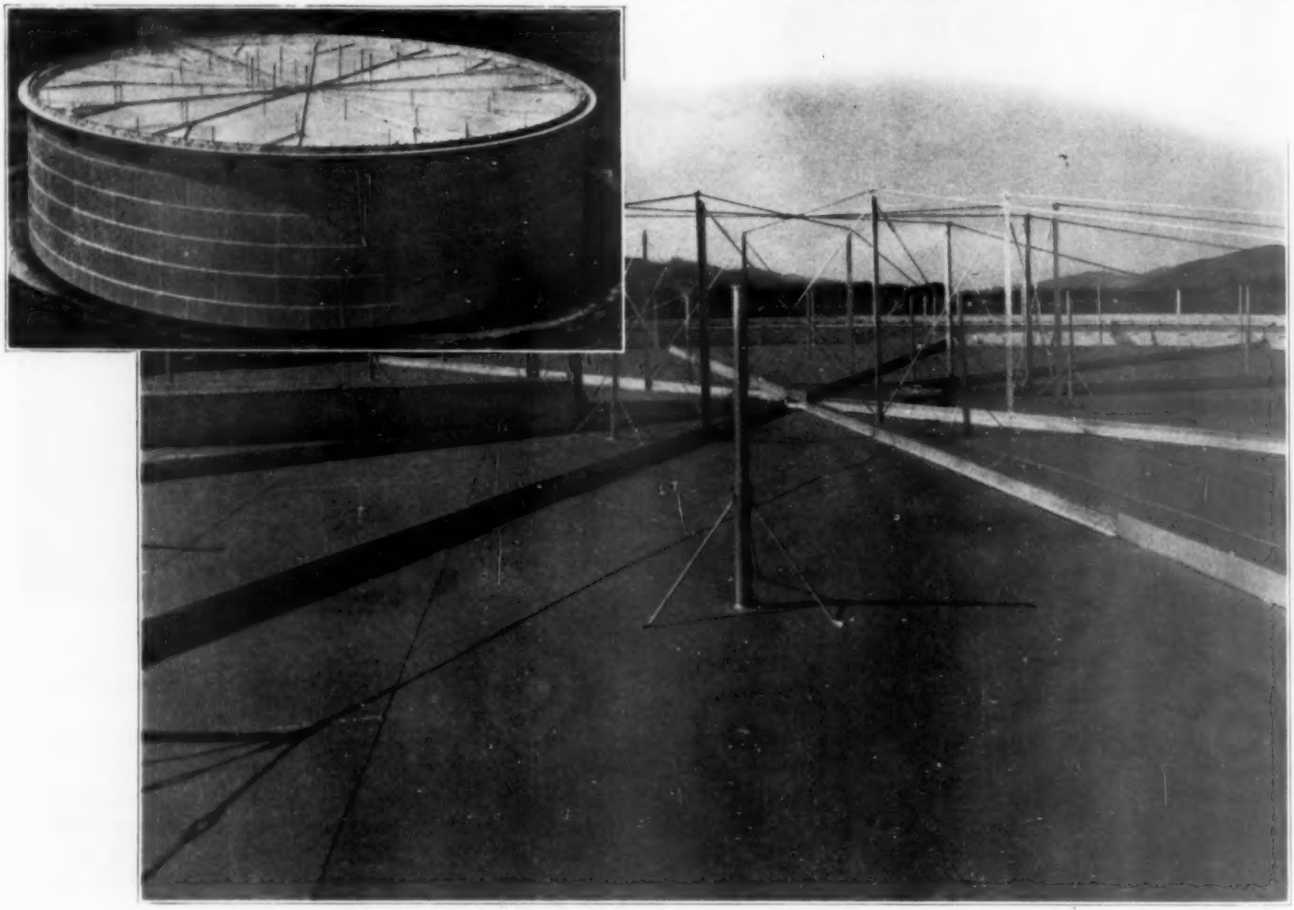

The Wiggins Floating Roof for oil storage tanks, is a well known example of large scale production welding. The tank shown in the insert is 114½ feet in diameter and over thirty feet high. The roof is of 3/16" plate and the bottom of ¼" plate. Many thousand feet of welding are involved in the construction of one of these tanks. Arc welding has proven to be the most satisfactory way to build the roofs and bottoms.

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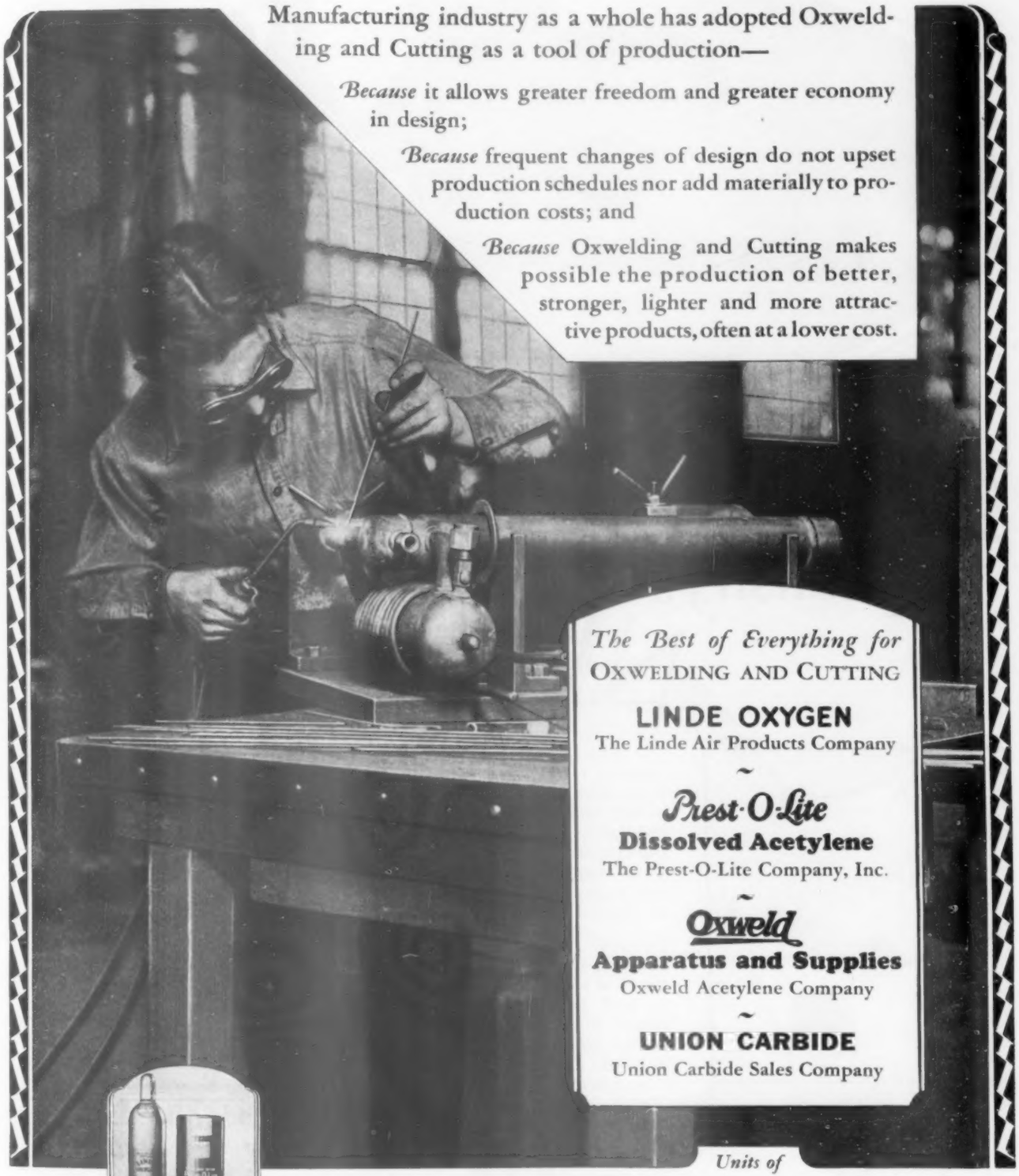

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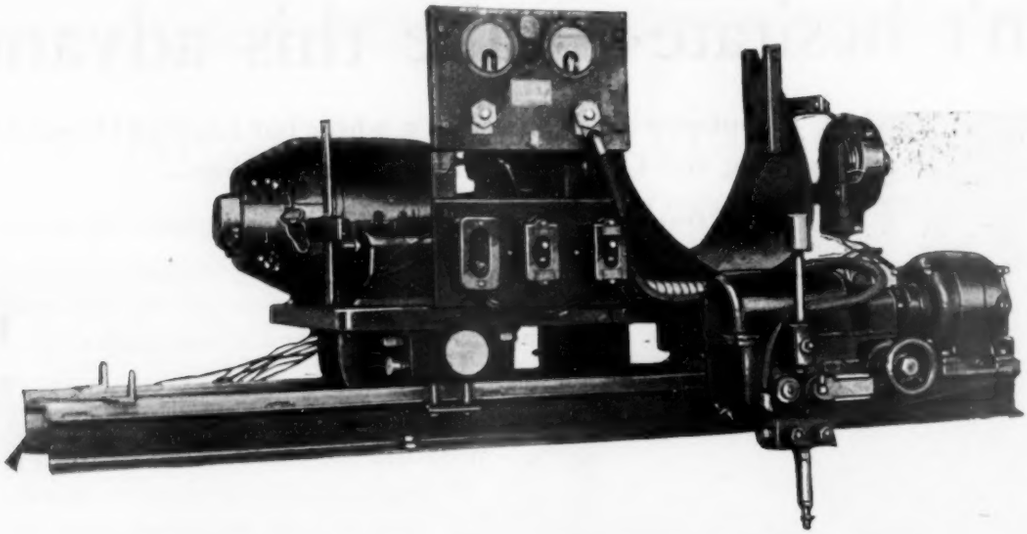

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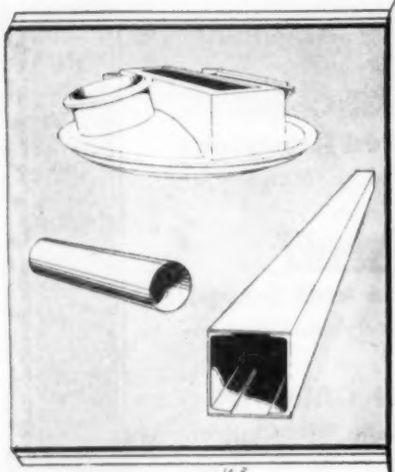

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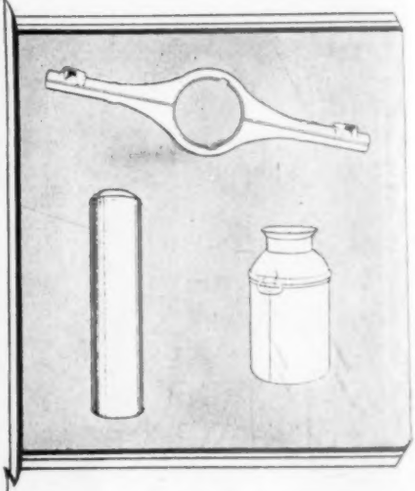

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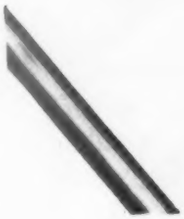

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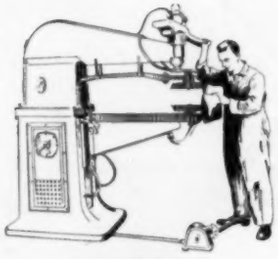

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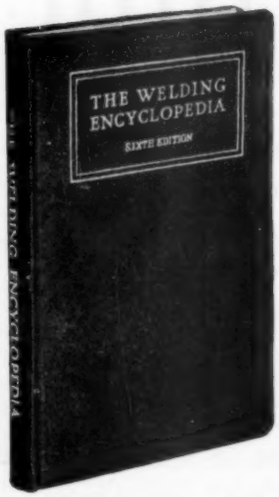

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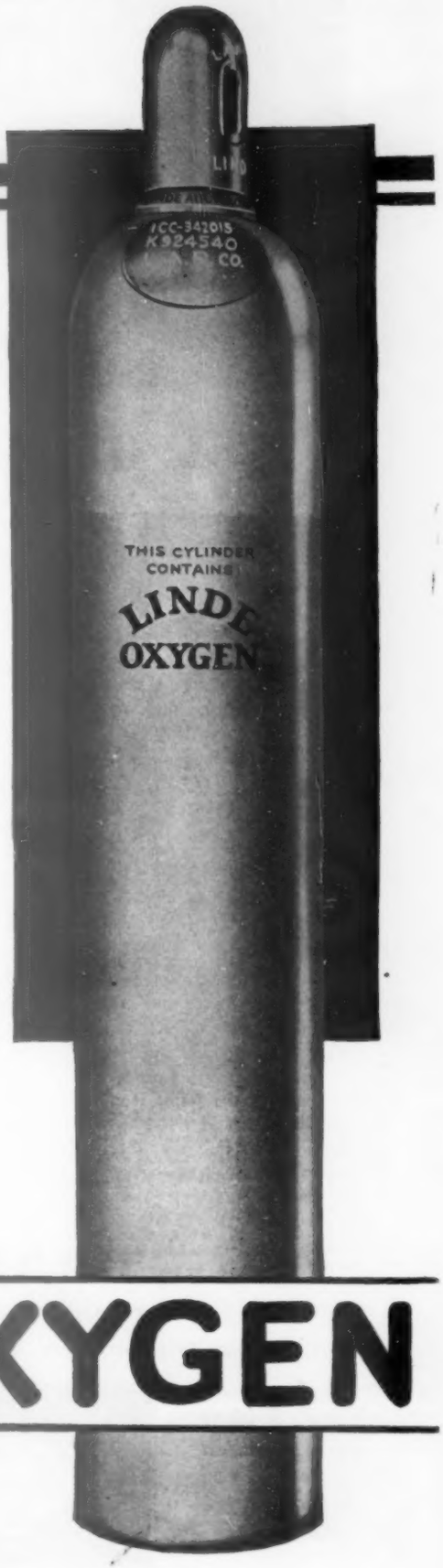
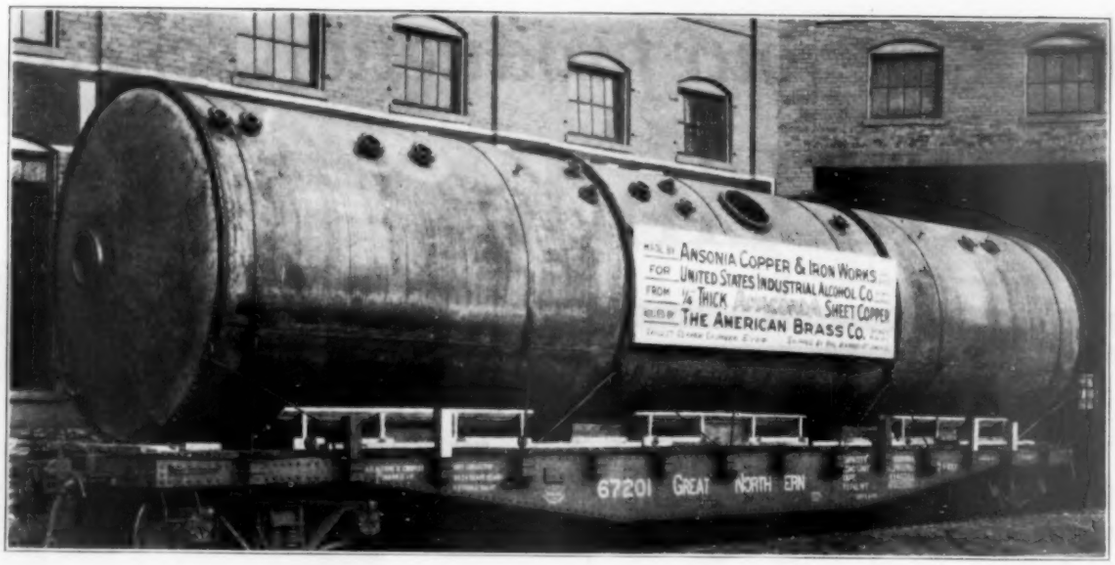


LINDE OXYGEN


ANSONIA COPPER & IRON WORKS
FOR UNITED STATES INDUSTRIAL ALCOHOL CO.
FROM ⅛ THICK SHEET COPPER
THE AMERICAN BRASS CO.
67201 GREAT NORTHERN

This 12-Ton Copper Still

And Its Network of Tubes and Headers Brazed with

"Handy" Silver Solders

AT Cincinnati, Ohio, the Handy Silver Solder-man was fortunate to call on a large coppersmith just as the largest copper still ever produced in America was being loaded for shipment to a large industrial alcohol works at Peoria, Ill.

This tank is 51 ft. long, 10½ ft. in diameter, and weighs 12 tons—or about 14 tons with its 4 in. coils and 6 in. headers.

There is not a rivet in it! All seams are brazed with Handy "BT" Silver Solder. The cylinder is made up of nine 133x195¼ in. plates of ¼ in. copper weighing 18,300 lbs. Heads are 133 in. circles of hot rolled ¼ in. copper weighing 2700 lbs.

When the cylinder was complete it was tested with air at 5 lbs. pressure. Coils were subjected to 200 lbs. hydrostatic pressure for 20 minutes. In neither case did a single leak develop! Sample sections of seams, tested by the Johns Hopkins University, withstood a pull test equivalent to 29,000 lbs. per sq. in., the failure occurring in the copper, close to the seam, and not in the seam.

Let Us Help!

Put all your soldering, welding or brazing problems up to us. Our testing laboratory and staff are at your service.

Replaces Tobin Bronze Brazing

The Vice President of the plant producing this mammoth still said:

"Before we discovered your silver solder we used to braze our copper stills and tubing with Tobin bronze. But our customers found that the butyl acetate used in their process attacked the zinc in the Tobin joints. As a matter of fact, they rarely got more than 6 months' service out of them. We now use Handy Silver Solders on all such work. Our crews who travel all over the country also carry this solder with them for use in repair and construction work that is likely to encounter acids. We are delighted at the service Handy Silver Solders give us and are glad we discovered them."

Wide Range of Uses

Contrast that great job with the pin-point of the same solder that is used on delicate parts of dainty wrist watches; and you have a mental picture of the range of uses of Handy Silver Solder.

Handy Silver Solders

should be used in all work likely to encounter heat, shock vibration or corrosion. They make neat, tight joints quickly and—all costs counted—are frequently the cheapest solders you can buy.

HANDY & HARMAN

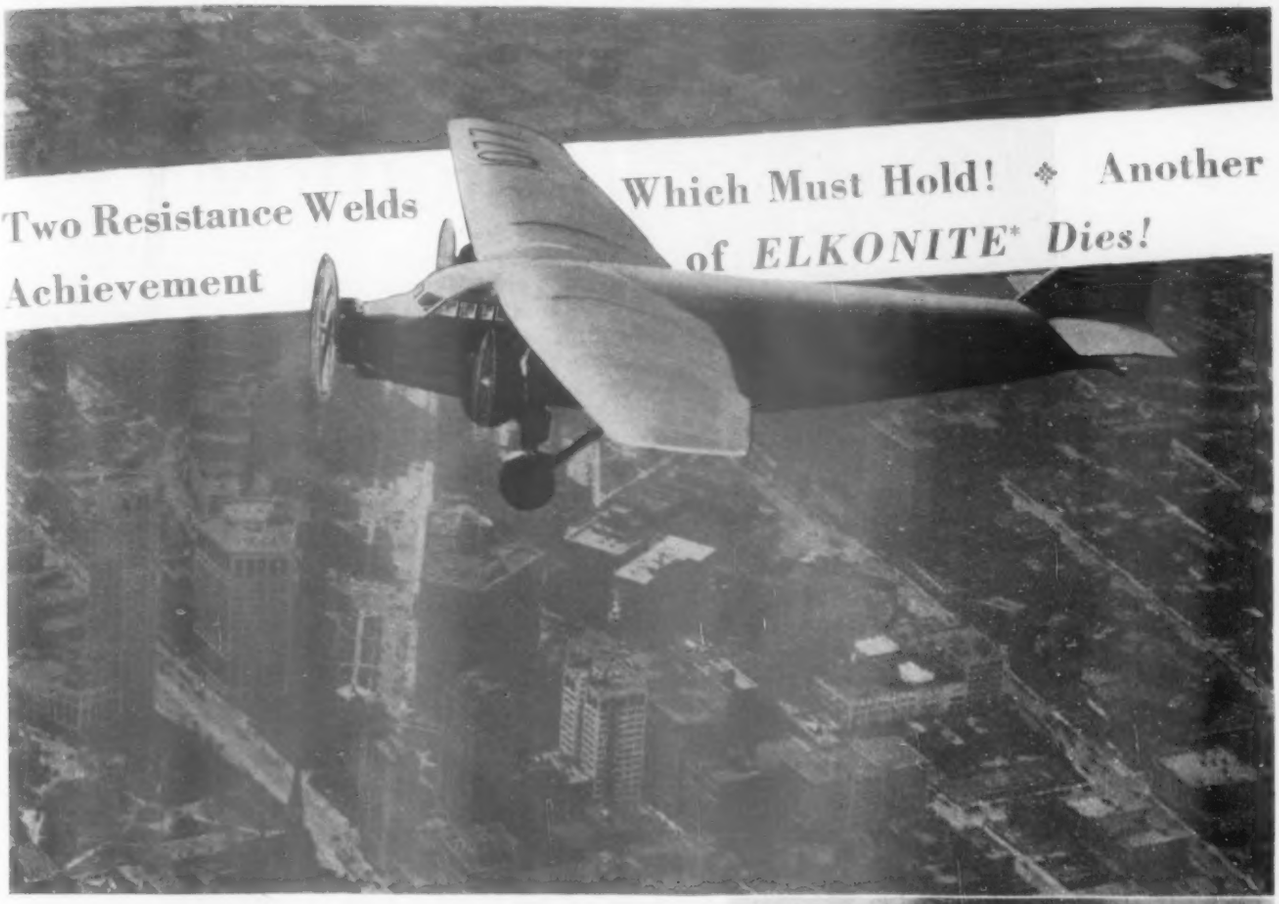
***General Offices*—57 William Street, New York, N. Y.**

Plants: Bridgeton, Conn.; Providence, R. I.; Fulton and Gold Sts., New York, N. Y.

Handy Solders are supplied in sheets, strips, wire and filings

Handy & Harman Plant, Bridgeport, Conn.

Our "Handy Book of Silver Solder" W, will interest you. Send for your copy.



Two Resistance Welds Which Must Hold! ✥ Another Achievement of *ELKONITE** *Dies!*

THE Ford plane shown above has two vitally important welds—One joins the terminals on the strut supporting the landing gear—

The second is in the motor fitting—

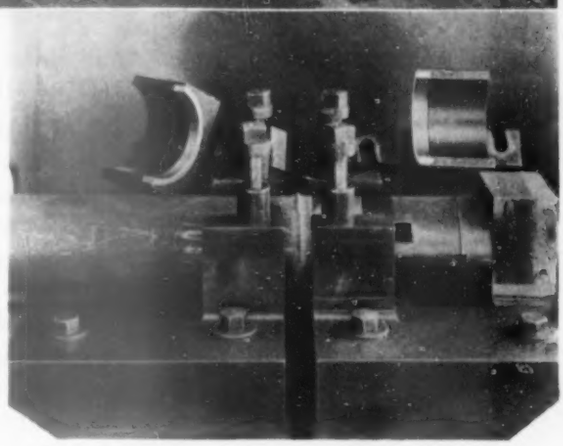
Absolute confidence in the strength of each must be assured. * * *

Copper dies on the landing gear weld lasted for only 50 welds. They were replaced with Elkonite dies which at the time of recording had made 600 welds and were still operating efficiently.

As for the motor filling weld—copper proved to be impractical. Alignment of the bars welded had to be kept within .005".

Because of their rapid wear, the copper dies had to be replaced after a few welds while the Elkonite dies now used have made over 600 perfect welds as to quality and alignment! And they are still running.

This is only one of the many applications on which Elkonite has paid for itself many times over in reduced labor and material costs and has greatly increased the factory output. Our Engineers will be glad to tell you how Elkonite can be applied to your resistance welding operations—no obligation, of course.



Before and after welding the terminal on the strut supporting landing gear. Copper dies made about 50 welds. Elkonite dies have made over 600 perfect welds and are still operating. This is only one of the many resistance welding applications in the Ford Industries on which Elkonite has cut production costs and increased output.

***ELKON*, Inc. (*Elkonite* Dept.)**

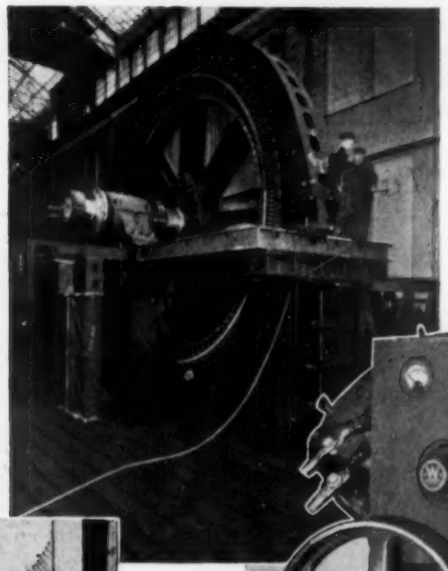
div. P. R. Mallory & Co., Inc.

350 Madison Avenue New York

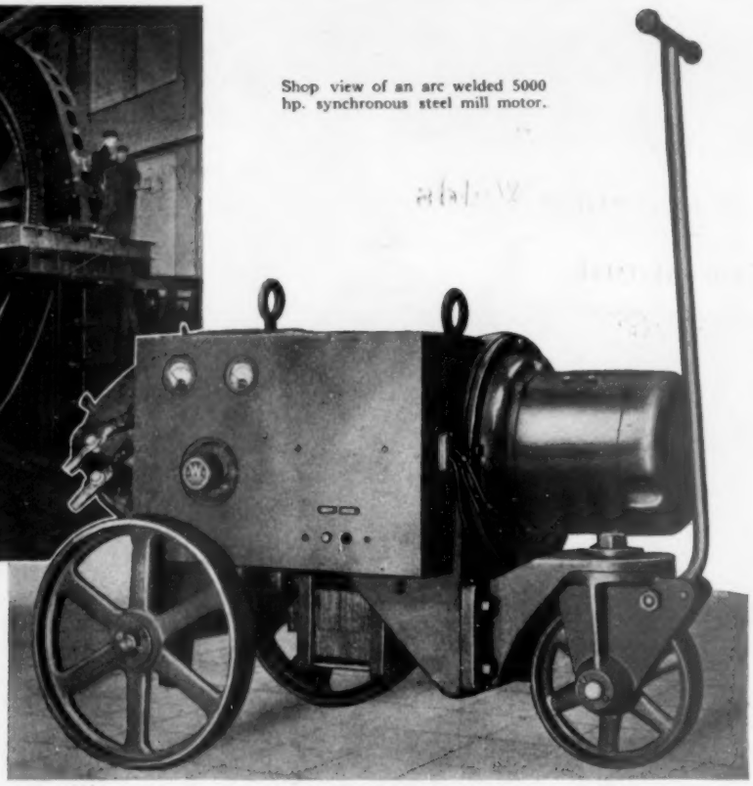
*Reg. U. S. Pat. Off.

ELKONITE

REG. U.S. PAT. OFF.



Shop view of an arc welded 5000 hp. synchronous steel mill motor.



Man and Machine

THE welder's best friend is a good welding machine. It helps him to work swiftly and surely--to get the full value of his skill. Consequently, his job is also the job of the set which must respond with exacting performance to every demand--whether it be a long, continuous grind or some emergency job.

Fast work and perfect welds are produced with a Westinghouse welding set because the generator produces a steady and penetrating arc which is easy to strike and maintain. Positive control of the current value is obtained by a single dial rheostat. This machine will stand the gaff of rough usage in shop or field because of its compactness and sturdiness.

Working with such a set, the welder can employ his skill in building a dependable product. Thus, the welders--man and machine--today contribute the marked economic benefit of arc welding to many industries.

Westinghouse Welders

200, 300 and 400-ampere a-c.--d-c. sets
300-ampere d-c.--d-c. set
200-ampere Gas-Engine Driven set
Automatic Seam Welder

Westinghouse Electric & Manufacturing Company
East Pittsburgh Pennsylvania

Sales Offices in all Principal Cities of the United States and Foreign Countries

Westinghouse

T 30323

Not a Defect in Twelve Million Welds!

Welding ¼ inch .40 carbon steel to 5/16 inch .18 carbon steel by the Federal Projection Method; welding two, four or six projections in one operation; completing bumper assembly (12 welds in each) on a Federal Projection Welder at 6 cents per bumper for labor and power—and this without a single defect in a million bumpers (12 million welds).

This Federal record is worth consideration, for though you may not want to weld bumpers Federal engineers can promise you equally interesting results on any other type of work. Let Federal Welding specialists recommend the standard, or develop the special welding machine to meet your need profitably.

FEDERAL PROJECTION WELDING

Type 612-B
Heavy Duty Spot Welder

Federal Welders

BUTT
SPOT
SEAM

FEDERAL MACHINE & WELDER CO.
Dana Avenue, Warren, Ohio, U.S.A.
Branch Offices In All Principal Cities

ELECTRIC WELDING

REQUIRES AN EFFICIENT TRANSFORMER

In choosing the transformer for your welding machine, three factors are of utmost importance:

1. Flexibility—(to suit any circuit).
2. Reliability—(24 hour service, without interruption, if necessary).
3. Economy—(long life with a minimum of repairs).

The American Transformer Company has consistently endeavored to uphold these standards of efficiency. In the welding industry they have closely followed each new development. The result is a staff of engineers competent to advise you on your electric welding problem regardless of its unusualities. Their advice entails no obligation, of course.

AMERICAN TRANSFORMER COMPANY
174 Emmet St., Newark, N. J.

Representatives

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W. O. Taylor & Co., Ltd.
415 Canada Cement B'ldg.

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Chicago, Ill.
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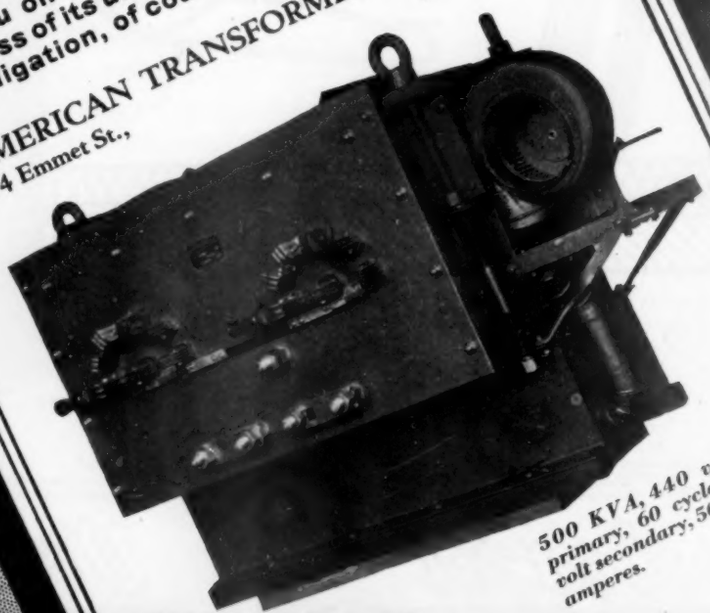
Philadelphia, Pa.
L. D. Joralemon
112 South 16th Street

St. Louis, Mo.
J. W. Jones
432 Pennant B'ldg.



500 KVA, 440 volt primary, 60 cycle 10 volt secondary, 50,000 amperes.

AMERICAN TRANSFORMER

The Gauge . . .

. . . the welders trust

ASK the men who do the welding . . . . . they know! They use Natweld Gauges every day; they realize how dependable, how accurate, how altogether trustworthy are Natweld Gauges . . . . . every single one of them.

Their knowledge comes from experience . . . . . the surest teacher of all. And such experience counts far more with them, and with us, than reams of other praise.

To you who buy gauges let us say also: Heavy demand has so built up our production facilities that Natweld prices are extremely low. Let us quote on your requirements.

National Gauge & Equipment Company
LA CROSSE, WISCONSIN
Division of The MotoMeter Company, Inc.

Represented in Illinois, Indiana, Wisconsin, Minnesota and Missouri by Joseph Halla.
333 N. Michigan Ave., Chicago, Ill.
Elsewhere, National Gauge & Equipment Co., 820 Tower Court, Chicago.
The MotoMeter Co. of Canada, Ltd., Hamilton, Ontario.

PREST-O-WELD

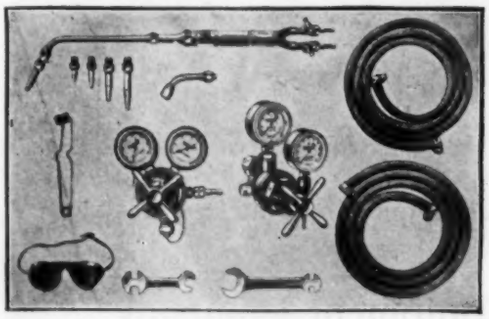
for Bigger Profits!

THE number of broken parts reclaimed by the oxy-acetylene process is increasing daily. This means more work and bigger profits for the shop that is equipped with a Prest-O-Weld Welding Outfit.

Prest-O-Weld produces real profits from both big and little jobs. Any good mechanic can readily learn to use it and with reasonable practice can do the average range of welding.

Prest-O-Weld equipment prices are especially attractive.

Made by the largest manufacturers of oxy-acetylene apparatus in the World. Prest-O-Weld is sold by jobbers everywhere.



Prest-O-Weld Welding Outfit No. W-101
Price $75.00
Other utility outfits as low as $49.50

OXWELD ACETYLENE COMPANY - - - *Unit of Union Carbide and Carbon Corporation*

UCC

NEW YORK: Carbide and Carbon Building
CHICAGO: Railway Exchange Bldg.
SAN FRANCISCO: Adam Grant Bldg.

Roebling

Welding Wire

ROEBLING Welding Wire is used where only the highest quality of welding wire is acceptable.

It can always be relied upon for ease of welding; a deposited metal which is strong, tough and durable, and uniform.

Tell us the kind of metal you want to weld and we will supply wire which will give the most satisfactory results.

Send for catalog A-529

John A. Roebling's Sons Company
Trenton, New Jersey

MECO SPECIAL PIPE WELDING TORCH
has the right shape, balance and flexible capacity to make it adaptable to all pipe welding conditions.

Good Pipe Welding Comes Naturally with This Torch— It Is Built for the Job

Meco

WELDING TORCHES

Approved by the Underwriters

Wherever fine pipe welding is done you will find MECO apparatus a strong favorite. The torch pictured above is designed especially for pipe work. It has all the standard MECO features of excellence and in addition it is just the right size and weight for this class of welding. Send for complete details of this torch.

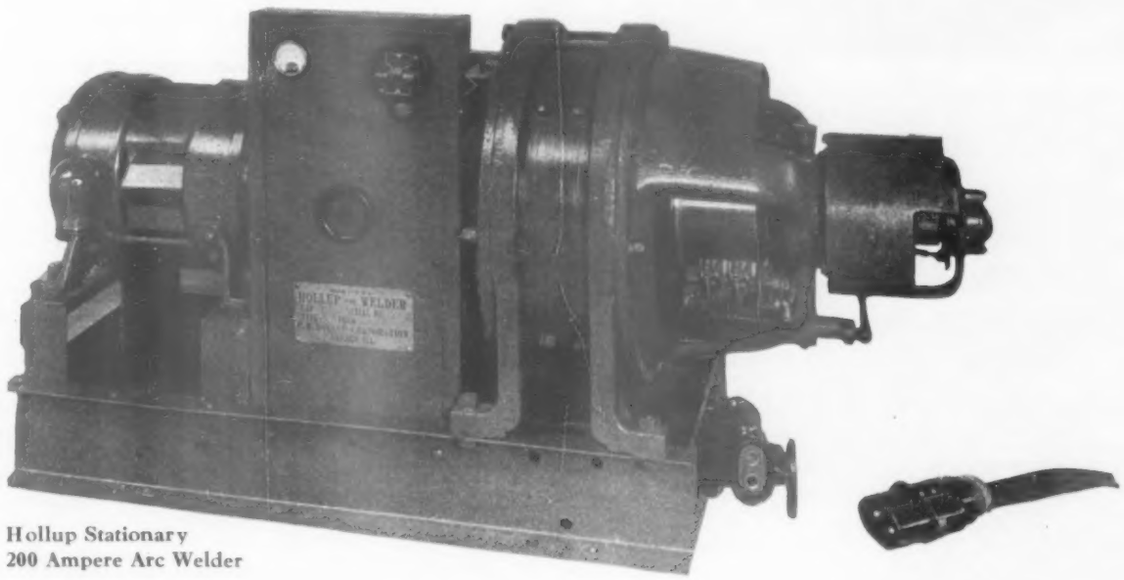
MODERN ENGINEERING COMPANY
3411 Pine Blvd. St. Louis, Mo.

Sales and Service in All Parts of the United States. Write for the address of our nearest representatives.

For Continuous-Duty Production Welding

HOLLUP Arc Welders will deliver current at rated capacity for hours at a time without harmful overheating. The welding arc will respond immediately to any demand put upon it. These two characteristics are of vital importance in production welding machines.

Large commutator and large brush area assure perfect commutation at all loads. Maintenance and spare parts cost is thus kept at a minimum. Where day-in and day-out service is demanded by the production schedule, this is the ideal machine.



Hollup Stationary
200 Ampere Arc Welder

HOLLUP ENGINEERING SERVICE

THE C. H. Hollup Corporation offers you, without cost, the benefit of its wide experience with electric arc welding applications, materials and apparatus. We are continually conducting research investigations of our own with the dual purpose of improving our products and of developing new uses for the process. The benefit of this experience is yours for the asking. We shall also be glad to make special investigations to meet special conditions and to develop special electrode materials where necessary.

C. H. HOLLUP CORPORATION

3333 W. 48th Place Chicago, Ill.

We couldn't improve the product—

but we are constantly improving the service

In any plant opportunities are always present to use the torch for dismantling, repair work, or for alterations of buildings and equipment. These opportunities are not always obvious. Our representatives are trained to help you save money around the plant by using the torch.

THE plants listed below have subscribed to a standard of 99.5% purity or better of the oxygen which they sell. There are no higher standards of oxygen production anywhere.

The perfection of their product is supplemented by a constantly increasing service to their customers. Each plant is a local industry and each plant manager is your neighbor, a man thoroughly familiar with local conditions.

Delivery facilities and an ample supply of cylinders is the starting point of a broad-gauged service. In order to meet every welding and cutting need many of these plants carry stocks of everything used for welding and cutting, including oxygen, acetylene, carbide, hydrogen, welding and cutting equipment, and welding rods.

You will also find these plants well organized to assist you in using welding and cutting in your plant to the best advantage and with greatest economies. A representative of the plant nearest you will be glad to call and explain in detail the scope of his service.

Buy at Home From Your Neighbors

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Birmingham—Burdett Oxygen Co.
Birmingham — Standard Gas Products Co. of Alabama.
Mobile—Louisiana Oxygen Co.

ARKANSAS
El Dorado—The Beaird Corporation.
Little Rock—The Beaird Corporation.

DELAWARE
Wilmington—Paschall Oxygen Co.

GEORGIA
Atlanta—Burdett Oxygen Co.

ILLINOIS
Chicago—Burdett Oxygen & Hydrogen Co. of Chicago.
Chicago—Swift and Company.
Elgin—Wisconsin Oxygen-Hydrogen Co.
Freeport — Wisconsin Oxygen-Hydrogen Co.
Peoria—Electrox Co.
Rockford — Wisconsin Oxygen-Hydrogen Co.

INDIANA
Evansville—Kentucky Oxygen-Hydrogen Co.
Indianapolis — Indiana Oxygen Co.
South Bend—Burdett Oxygen-Hydrogen Co. of Chicago.

KENTUCKY
Louisville — Kentucky Oxygen-Hydrogen Co.

LOUISIANA
Monroe—The Beaird Corporation.
New Orleans—Louisiana Oxygen Co.
Shreveport—The Beaird Corporation.

MICHIGAN
Detroit—Burdett Oxygen Co. of Detroit.
Grand Rapids—Grand Rapids Welding Supply Co., Inc.
Kalamazoo — Grand Rapids Welding Supply Co.

MINNESOTA
Minneapolis — Commercial Gas Co.

MISSOURI
Kansas City—Kansas City Oxygen Gas Co.
Kansas City—Ox-Hydrogen Mfg. Co.

MONTANA
Butte — Mountaineer Welders' Supply Co.

NEBRASKA
Omaha—The Balbach Co.

NEW JERSEY
Camden—Paschall Oxygen Co.
Newark—International Oxygen Co.
New Brunswick—International Oxygen Co.
Paterson — International Oxygen Co.
Plainfield—International Oxygen Co.
Trenton — Paschall Oxygen Company.
Trenton—International Oxygen Co.

NEW YORK
Brooklyn — International Oxygen Co.
Long Island City — International Oxygen Co.
New York—International Oxygen Co.

OHIO
Cincinnati—Ohio Valley Oxygen Co.
Cleveland—Burdett Oxygen Co. of Cleveland.
Columbus—Gas Products Co.
Toledo — International Oxygen Co.

OKLAHOMA
Oklahoma City — The Burdett Oxygen Co. of Oklahoma.

OREGON
Astoria—Portland Oxygen & Hydrogen Company.
Bend—Portland Oxygen & Hydrogen Company.
Corvallis—Portland Oxygen & Hydrogen Company.
Eugene—Portland Oxygen & Hydrogen Company.
Klamath Falls—Portland Oxygen & Hydrogen Co.
Medford—Portland Oxygen & Hydrogen Company.
Pendleton — Portland Oxygen & Hydrogen Company.
Portland—Portland Oxygen & Hydrogen Co.
Roseburg—Portland Oxygen & Hydrogen Company.

PENNSYLVANIA
Allentown — Paschall Oxygen Company.
Lancaster — Paschall Oxygen Company.
Lebanon — Paschall Oxygen Company.
Philadelphia—Paschall Oxygen Co.
Pittsburgh—Burdett Oxygen & Hydrogen Co.
Reading—Paschall Oxygen Company.
Verona—International Oxygen Co.
York—Paschall Oxygen Company.

TENNESSEE
Chattanooga—Burdett Oxygen Co. (of Chattanooga).
Knoxville—Burdett Oxygen Co. (of Chattanooga).
Nashville—Burdett Oxygen Co. (of Chattanooga.)
Nashville — Kentucky Oxygen-Hydrogen Co.

TEXAS
Austin—Capital Battery Co. (Burdett.)
Beaumont—Magnolia Gas Products Company.
Dallas—American Welding Co. (Burdett.)
Ft. Worth—Burdett Oxygen Co. of Texas.
Galveston—Gregory Auto Supply Co. (Magnolia.)
Houston—Magnolia Gas Products Co.
Ranger—Oil Belt Welding Supply Co. (Burdett.)
San Antonio — Magnolia Gas Products Co.
Temple—Russell Transfer Co. (Burdett.)
Waco—McCrary Transfer Co. (Burdett.)
Wichita Falls—Burdett Oxygen Co. of Texas.

WASHINGTON
Spokane—Spokane Oxy-Acetylene Co.

WISCONSIN
Appleton — Universal Oxygen Co.
Beloit—Wisconsin Oxygen-Hydrogen Co.
Fond du Lac—Universal Oxygen Co.
Green Bay—Universal Oxygen Co.
Janesville—Wisconsin Oxygen-Hydrogen Co.
Kenosha — Wisconsin Oxygen-Hydrogen Co.
Lake Geneva—Wisconsin Oxygen-Hydrogen Co.
Madison—Universal Oxygen Co.
Manitowoc—Universal Oxygen Co.
Milwaukee — Universal Oxygen Co.
Oshkosh — Wisconsin Oxygen-Hydrogen Co.
Racine—Wisconsin Oxygen-Hydrogen Co.
Sheboygan—Universal Oxygen Co.

HAWAII
Honolulu—Hawaiian Gas Products, Ltd.

BOLD FACE TYPE signifies Manufacturing Plants.
LIGHT FACE TYPE indicates warehouses.

Gas Products Association

333 N. Michigan Ave. **Chicago, Ill.**

First to Advocate High Purity Oxygen

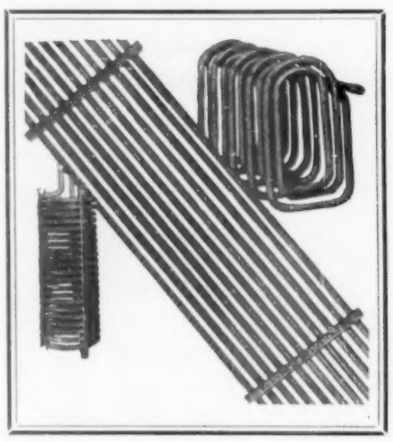
"If you're as exacting as we are—you'll want Harrisburg coils and bends"

"Some men are still paying for piping installations they bought years ago —paying in shutdowns, repairs, efficiency losses and production wastes.

"Other men go to Harrisburg, just as we did, for their coils and bends and enjoy low maintenance costs—freedom from trouble, and service that must be experienced to be appreciated.

"If you're as critical as we are—if only the best will do—let Harrisburg quote on ***your*** coil and bend requirements. I'll tell you Harrisburg's 40 years' experience is worth something."

Fully Equipped with Our Own Open Hearth Furnaces, Rolling Mills and Forge Shops

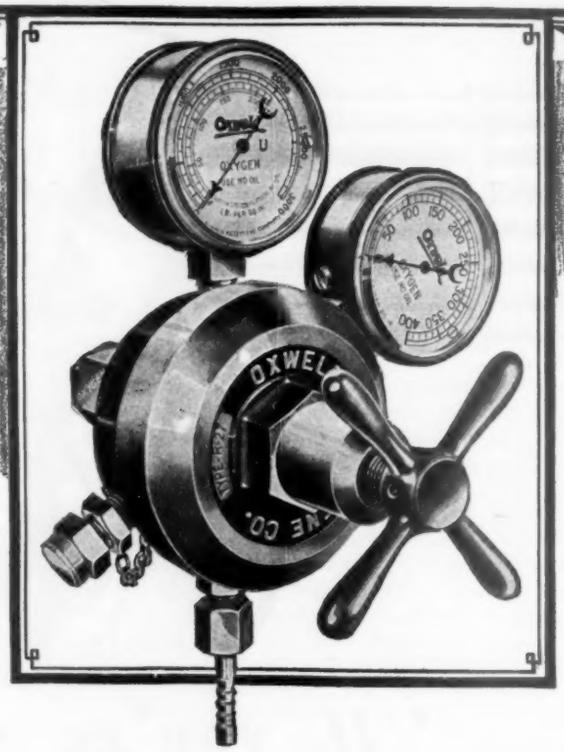


HARRISBURG PIPE & PIPE BENDING CO.
Harrisburg, Pa.

Makers of Alloy Steels in Slabs, Billets, Bars, Strips, Shapes and Hollow Forgings; Pipe Coils and Bends, Couplings and Cylinders.

HARRISBURG

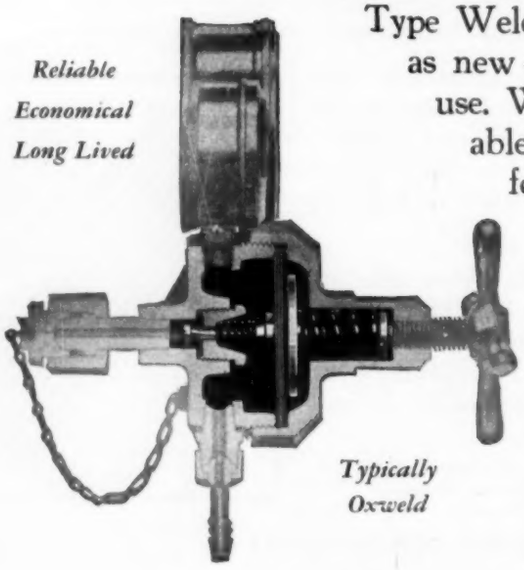
COILS and BENDS



Will $3.60 buy a new Oxygen Regulator?

No! *But* $3.60 will make an Oxweld Stem Type Welding and Cutting Regulator as good as new — even after it has had years of hard use. Why? Because simplicity of design enables you to buy the whole "inside works" for $3.60!

Reliable
Economical
Long Lived



Typically Oxweld

Oxweld Regulators are built to last. Rugged — no delicate mechanism — plenty of the right material in the right place. Design permits gas flow in any desired quantity. Uniformly dependable for accurate and steady reduction of pressure from cylinder to blowpipe on every type of oxy-acetylene welding and cutting work.

OXWELD

WELDING AND CUTTING APPARATUS AND SUPPLIES

OXWELD ACETYLENE COMPANY

Unit of Union Carbide and Carbon Corporation

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NEW YORK
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Peoples Gas Building

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You Can Bank on Mueller Welding Bronze — and on Mueller Service

YOU will find that Mueller Welding Bronze Rod will give you the same definite result time after time. It has all the qualities that you would expect to find in a real product. It is strong and close grained . . . It melts easily and flows freely. Absence of porosity eliminates sputtering and explosions.

Mueller Welding Rod is distinguished by the wording "Mueller Welding Bronze" stamped every few inches on the rod itself.

For a special job that must machine easily or take a high finish — or for any job — you can depend on it to give you the results you must have.

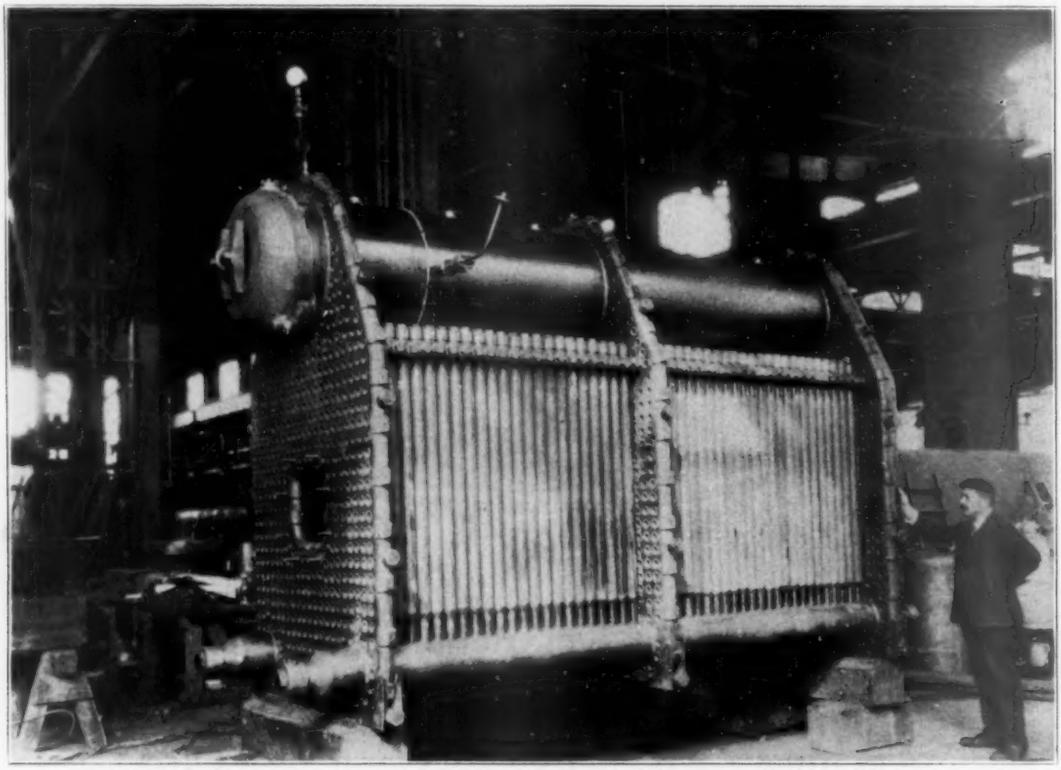
When you are in a hurry you can depend upon quick delivery, too.

Mueller Brass Co.
PORT HURON MICHIGAN

THREE GENERATIONS OF BRASS MAKING

Quasi-Arc

AN ACHIEVEMENT IN BOILER CONSTRUCTION



Locomotive Boiler for 850 lbs. per sq. in. Working Pressure

MADE POSSIBLE BY QUASI-ARC ELECTRODES

This remarkable project was attempted only after the designer had made exhaustive tests which proved that welding with Quasi-Arc Electrodes was the only method which fulfilled the severe technical requirements. Nothing short of a perfect weld could be considered in such an undertaking, and the results offer unquestioned proof of the tightness and ductility of welds made with Quasi-Arc Electrodes.

Have you ever considered the vast possibilities of utilizing such quality on every-day production work? We are ready to show you by means of a practical demonstration that speed, smaller deposits, and all-around higher efficiency made Quasi-Arc Electrodes the *most economical* in the final analysis. Such a demonstration will not obligate you in any way. Why not look into the matter?

QUASI-ARC INCORPORATED

Sole Manufacturers of Quasi-Arc Electrodes and Welding Equipments and Consultants in Reference to their Application

11 WEST 42nd STREET, NEW YORK, N. Y.

EL PASO, TEXAS CHICAGO, ILL. CLEVELAND, O. PORTLAND, ORE.

EDITORIAL

The Man for the Job

WHEN the Chief Justice of the Supreme Court of the United States swears in as president, Mr. Herbert Hoover, on the fourth day of next month, a mantle of responsibility falls on Mr. Hoover greater than that of the leader of any other nation. The significance of his appointment to that position of authority is of importance to every one living under the rule of the United States government. This nation of ours is predominantly a nation of workers. We are wrapped up in making a living and securing better opportunities for our children. The keynote of our national life is commercial. From a wilderness of natural resources we have built a world power in one hundred and fifty years and the complexity of such rapid development of material wealth is beginning to crowd us. We need, if we are to continue to maintain our rising standard of living and to assure to all of us a continuation of material progress, a kind of thinking in this powerful office of national leadership, which we call the presidency, which will assure a national program of advance. Aside from all considerations of partisanship we recognize in Mr. Hoover's acceptance of this office an opportunity to put the vision of all the past into terms of the practical realities of the present. If there be such a thing as education for the presidency he has received it. It seems to us that we have here the man for the job who will make it worth while for us to help him to give his best to that job.

Welding Appears as a National Necessity

WHILE the announcement of Germany's new all-welded battleships may come as a surprise to many in the welding industry there are plenty of men in naval circles who are quite prepared for this development. Such construction does not call for any more highly developed knowledge of the principals and application of welding than that which is available to our own builders, for it is not too much to say that our own country really leads the world as far as welding is concerned. In the case of a battleship there is an obvious advantage in being able to increase the operating capacity of the ship without increasing its weight, and a saving of one thousand tons in material is a considerable saving. Under the circumstances it is reasonable to assume that this saving in weight is worth while regardless of cost. The incident is of considerable interest to the welding industry because it shows on such a large scale the advantage of welding from a point of view of reducing weight of the completed structure without reducing its serviceability or of increasing the serviceability without increasing weight.

The Los Angeles Exposition

ACCORDING to most of the reports heard of the Western Metal Congress which was held at Los Angeles last month, the only disappointment in connection with this meeting was that felt by those who were unable to attend. The Western Coast representatives of national manufacturers gave some keen competition to local manufacturers in the preparation of exhibits calculated to arouse interest in the most modern metal working processes. The location of the meeting was a particularly interesting one. In the great Pacific Coast district there are hundreds of men who have labored for years under the handicap of being a long distance from important sources of supply of materials and equipment. This has necessitated a great deal of pioneer work in many branches of industry, the exercise of almost unbelievable ingenuity in the solution of problems which could be much easier handled in plants more favorably located. The handicap of location has brought out the best that there was in hundreds of very able engineers, with the result that a high degree of resourcefulness has been developed. It is natural that these men should welcome an opportunity to get together on a large scale and compare notes. Consequently it is not surprising that the attendance at the conference was unexpectedly large and was composed to an unusual degree of men in important executive positions. Exhibitors have commented freely on the success of the event from the point of view of sales, but even if this were not so it is pretty certain that the new interest given to development work in industries of the western district which is bound to result, is of enough importance to justify speaking of the Los Angeles meeting as a complete success.

A New Viewpoint on Pipe Fabrication

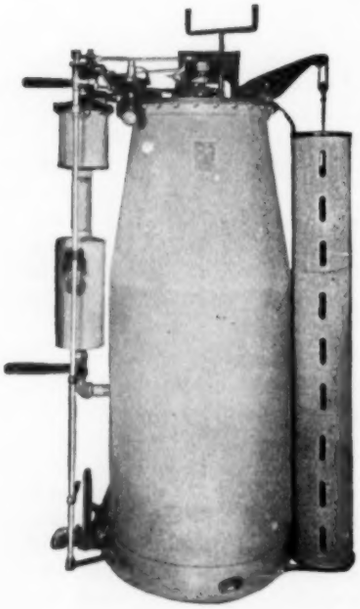
WITH the older methods of fabrication of pipe installations one of the most important and annoying items of expense was the special fitting, the fitting which had to be made to order for the particular job. Reference has often been made to this fact by those who advocated welding for all pipe installations. The point is very strongly emphasized in a recent advertisement of the Semet-Solvay Engineering Corporation, whose headline declares that there is no such thing as a special fitting. This is explained in an excerpt from their code of standards for fabricating pipe and fittings, which calls attention to the fact that almost any shape or special fitting can be made from steel, and recommends the elimination of flanges wherever possible when making pipe layouts. In the same advertisement a strong point is made of the fact that there is no pipe layout so complicated that it cannot be built under their standard shop practice. In other words, the special fitting may be a problem in the case of the engineer who sticks to old methods, but it has ceased to be a problem to the engineer who takes full advantage of welding because the latter can make any turn or combination he desires by means of simple assemblies of standard shapes.

Every Success Is Worth While

LAST month the Associated Press secured widespread publication of the story of the devotion of two firemen, who, under the direction of a physician, worked for twelve days with tanks of oxygen to save the life of a seven year old girl. A large share of the credit for their success was ascribed to the use of the oxygen. As time goes on, physicians may gain confidence in this kind of treatment and learn much more about its usefulness. As more is learned about its use the public should be kept informed that the supply of oxygen has become so staple that it is found in almost every village in the country. Fortunately the price is not so high as to exclude its use in emergencies of this sort. And fortunately also, the oxygen which is made for industrial purposes is of the highest possible purity so that for the most part a physician has no cause for worry as to the quality of the gas which he can buy in commercial containers for emergency treatments. It is not too much to expect that oxygen plants and warehouses in the future may be regarded in a way as life saving stations.

REGO

Automatic Acetylene Generators



Rego Stationary Generator

offer a convenient and safe source of acetylene supply to the large or small user at a saving that will frequently pay for the generator in a few months time. Industrial plants, pipe welding contractors and repair shops are increasing their profits and increasing their output with Rego generators, for the gas is not only cheaper, but they are assured of an unfailing source of supply.

REGO

Pioneered the development of a safe, medium pressure generator to meet the demands of portable use and was the first to build a machine of this type *safe enough* to pass the rigid requirements of the National Board of Fire Underwriters. Safety in every respect and under all conceivable conditions was our aim and the proof of our success is the fact that we have been permitted to rate the output of these generators at double the rate usually permitted.

REGO

Stationary generators for industrial plant installations have also passed the requirements of the National Board of Fire Underwriters. They provided that extra safety element always desirable, together with the assurance of a saving in gas cost and a flexibility permitting increased production within a wide range.

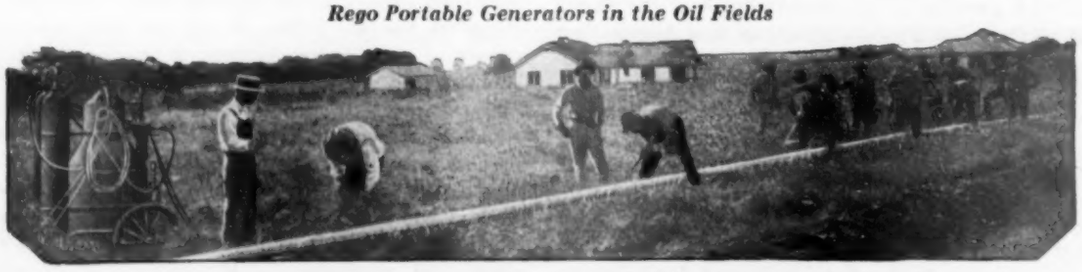
REGO

Generators are made in fifteen different sizes and types, ranging from 30 to 300 pounds carbide capacity at prices from $189.00 to $630.00. The new Rego catalog fully describes the generators and analyzes the possible savings you can make. Let us send you a copy.

THE BASTIAN-BLESSING COMPANY

240 East Ontario Street **Chicago, Illinois**

Rego Portable Generators in the Oil Fields



Problems in Welding Chrome-Nickel*

Alloys With High Coefficient of Expansion, Low Heat Conductivity, and Coarse, Irregular Grain Present a Difficult Welding Problem

By E. D. Flinterman†

TO meet the urgent need for developing methods of welding the chrome-nickel alloys, both in repair welding such as cracks and defects on castings in process and also on built-up jobs consisting of two or more castings to be used as a unit in service.

Our company manufactures a varied line of chrome-nickel and other high temperature alloys, but for several years we have concentrated on the one which seemed best suited to the majority of applications. It is what we call standard Misco. The analysis is 35% Ni., 15% Cr. with C. 45-65. Si. 1.20-1.40 and Mn. .60-.80.

This is distinctly an Austenitic Steel, and we have never been able to change the grain structure by any heat treatment.

In Fig. 1 you will note the coarse irregular appearance. The Microphotograph from which this slide was made was only magnified about 100 times. Compared with the regular .30 C. steel which we cast, the grain is very large, being about three to four times the size. In spite of this large grain, Misco as cast shows an average of 66,000 lbs. per sq. in. tensile with about 4% elongation and 6% reduction of area.

We have subjected Misco specimens to as radical heat treatment as quench in ice water from 2100 degrees F. with no apparent change in grain. However, pieces subjected to several thousand hours under a temperature of 1600 degrees F. seem to show some grain refinement. We have a metallurgist spending his entire time on high temperature alloys and hope sometime to discover a critical point which will enable us to control the irregular grain structure, which we believe will aid us in welding and machining.

The heat conductivity is very low. It is only .0247 C. G. S. units as compared with copper at 1.0 and C. I. at .07. Thus it is about 1-40th of copper and about ⅓ C. I. As you would expect with low heat conductivity, the electrical resistance is very high, being 673 ohms per mil. ft. at 70 degrees F.

Most materials show much better conductivity in rolled form than in cast and this is very apparent in Misco. The rolled Misco shows about 575 ohms per mil. ft., as compared with identical analysis as cast of 673. The rolled shows less resistance at 1800 degrees F. than the cast does cold, being only 642 ohms. I cite this to show that the grain as cast must be very jumbled about and the rolling lines up the grain to improve the conductivity.

The coefficient of expansion is slightly higher than .30 C. steel being .0000075 per degree F.

Thus, we are dealing with an alloy low in heat conductivity, high in expansion, with a coarse, irregular grain.

One of the first problems I came up against was welding carbonizing boxes, shown in Fig. 2. It is possible with the oxy-acetylene flame to make welds at the rim, near the bottom corners and around on the legs, but when you try the middle of the walls, the trouble begins. One can make a fine weld but when it cools to about 1000 or 1100 degrees F. a crack appears through what was the hottest area of the weld, and often it cracks wider than the welded area.

Apparently the heat is transmitted away from the weld very slowly. The area surrounding the weld is receiving the heat and expanding as the welded area is cooling faster from its higher temperature and contracting, and the pull of the surrounding area expanding simply pulls the weld apart while it is still weaker due to being at a higher temperature.

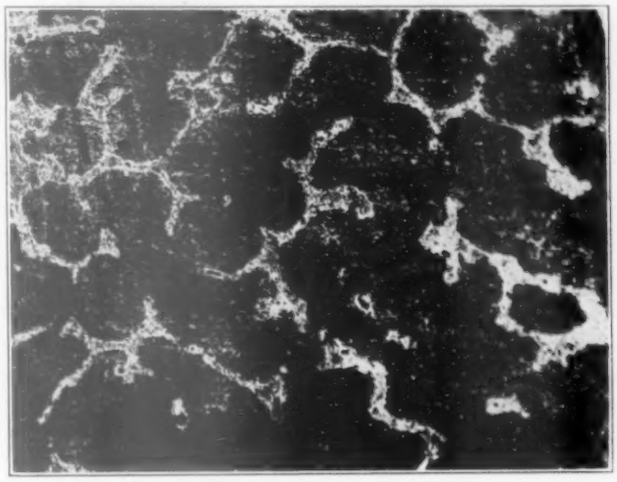


Fig. 1. 100X Magnification of Standard Misco Chrome-nickel Alloy.

The same thing occurred on all pieces. Trays, plates, discs, etc., are easily welded on the edges but not in the center area.

The method to stop this cracking naturally seemed to be one of preheating. So we tried all the common methods that were suggested to us, such as oil torch preheat, coke fire preheat—throwing into coke fire immediately after welding, and with two operators, one welding and the other heating around the weld. But no success rewarded our efforts.

The welding wire used on all welding was identical in analysis to the castings. Borax and borax base fluxes were used apparently with the best success.

At this time, employment was very low in Detroit and we were able to hire a successsion of welders and I attempted to try all the ideas that any of them could suggest. The men experienced on aluminum seemed to have the most ideas, and as far as possible we tried them all.

We had some shallow boxes to weld, about 15″x20″x4″ deep, and were doing rim cracks and leg welds nicely, but could do nothing in the middle of the bottom. A welder suggested immersing the box in water, open side up and welding

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*Paper read before Welding Conference at Purdue University, December 12-14, 1928.

†Sales Manager, Michigan Steel Casting Company, Detroit, Mich.

clear thru, building from the outside in. We found it possible to keep the water from entering by the pressure of the flame, but a large No. 12 tip was necessary. An apparently satisfactory weld was made, but the presence of water on the outside of the bottom only shortened the time between the completion of the weld and the occurrence of the crack.

We then went back to welding hot, and tried covering the weld immediately with cold silica sand, also hot sand, and various means of slow cooling, playing the torch down to about 1800° and then switching to oil torch below the point where the crack occurred, but with no success.

We then built a small fire brick furnace the size of the box and put the box on top of it for the roof. A high pressure oil torch was used, the flame being baffled, and heating the whole bottom of the box to any desired temperature. We found that about 1600° F. was as hot as an operator could work even with asbestos protection discs around the

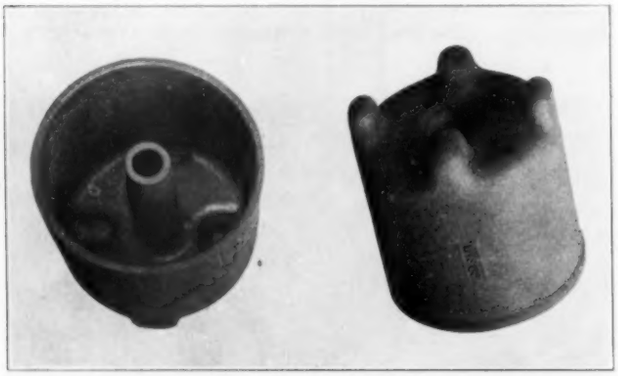


Fig. 2. Cracks in These Chrome-nickel Carbonizing Boxes Are Very Difficult to Weld.

welding wire and torch handle. Again, a beautiful weld was made and the box immediately covered over and the oil torch very gradually cut down. The result was always the same, a crack through the welded area.

I was so sure of this particular method that it was pursued from all possible angles. Welds were made while the casting was coming up to heat, while it was cooling and after it had reached equilibrium and even soaked for a few hours. Attempts were made to weld at a temperature so hot that we actually melted a corner off from one box, but this idea was abandoned because the welder could not get close enough or stay at the job long enough to make a good weld.

We had a cracked retort about 18" dia. and 6' long, cracked at one end. We closed this end except for a flue pipe and shot an oil torch flame in the other end. A satisfactory weld was made with the retort hot, but the crack occurred upon cooling. We have since been able to weld these retorts by annealing them several times before welding, but this does not help the boxes.

So far we have considered gas welding, but our experiments carried on at the same time included electric work. Most of our welding on steel castings is done on the D. C. carbon arc, with some metallic arc. Very little is done on the gas.

The carbon arc makes welds on Misco very much faster than the gas, but they are not as good physically, and the inability to use a flux satisfactorily gives the weld a spongy appearance instead of the silvery smoothness of the gas welds.

Our metallic arc experiments included both A. C. and D. C. but we have finally concentrated on the D. C. metallic arc. The chief difficulty lies in spongy weld and cracking in the weld bead. However, by using reversed polarity to cut down the heat in the object, we are successfully welding many jobs formerly considered doubtful. We are trying various flux coatings to overcome sponginess and have recently developed a flux, now undergoing thorough tests, which seems to accomplish this.

One job welded very successfully on D. C. is the dipping basket shown in Fig. 3. We previously made these round in one piece and experienced cracks which were unweldable,

Fig. 3. Cyanide Dipping Basket Misco Casting Welded Together.

probably due to strains in the castings due to contracting over the center core. But made of five flat pieces having no strains, the welding is very easy. The baskets very gradually get thin in use, but the welding holds and an extremely low basket hour cost has been the result.

A couple of years ago, when we began fabricating with rolled Misco, I thought we would encounter no difficulty whatsoever, and my predictions were almost true.

We weld up quite a bit of 2" and 3" dia. rolled Misco for furnace skid rails. Our mill lengths are about 12-15', neces-

Fig. 4. Angles of Chrome-nickel Sheet Bent Parallel with Grain Resists All Efforts to Weld Cracks.

sitating at least one weld per rail. We scarf these pieces on a milling machine to a flat wedge point, the included angle of the wedge being about 110°, which makes the included angle to be filled up about 70°. We do this with the gas weld, and have had no cracking, no warping of the rails upon cooling, nor in the repeated heating and cooling when in service in heat treat furnaces.

Small Misco fixtures made from ¼" and ⅜" rods are welded 100% with gas with no trouble at all.

Lately we have been doing welding on Misco sheets. Gas welds are apparently perfect on either the butt weld or lap weld. But the metallic arc is so much faster we are trying

to work the kinks out of this method. Spongy welds are the chief cause of trouble, with some tendency to crack in the bead. We are doing this all on D. C. The electric arc weld is also desirable because of localized heat. The heat due to longer operation with the gas tends to warp closed structures, making final assembly difficult.

We have had some sheets welded by atomic hydrogen process apparently very successfully. The amount of heat transmitted to the object to cause warpage is much less than with the gas, but more than with the D. C. metallic arc.

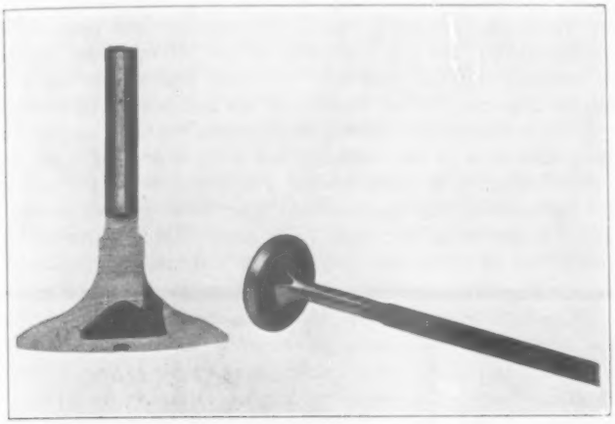


Fig. 5. Poppet Valves with Chrome-nickel Cast Head Welded to 60 Carbon Stem.

One unexpected difficulty run into in welding Misco sheet is seen in Fig. 4. This is an angle made from a Misco sheet about 16x60, several pieces being blanked out parallel, the grain running long way. These strips can be bent into hoops or squares, but in making the angles by bending parallel to the grain, cracking was experienced as shown on this piece. This particular piece was welded successfully where it cracked in the radius near the end, but we were unable to weld the cracks in the flanges even with preannealing and preheating and other preparations before and care after welding. The welding shown here is gas, but electric gave the same result.

About four years ago, we became interested in automotive poppet valves of the type shown in Fig. 5. The hollow head is a Misco casting. The head is made hollow to do away with the hot spot which occurs where the stem joints the head on a valve of ordinary construction. For two reasons the stem has to be a different alloy welded on, first because it is impractical to cast a long stem, and secondly because a Misco stem cannot be hardened. Hence the stem is a .60 carbon steel which can be easily quench hardened.

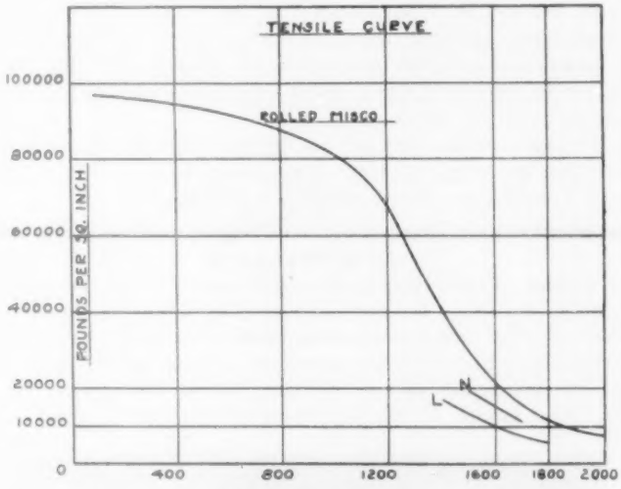
Considerable resistance was encountered among automotive engineers because of the electric butt weld of stem to head. To overcome this, we made up some test bars of several different alloys under consideration for the valve stems and heads.

The complete curve shown in Fig. 6 is rolled Misco. It is interesting at this time to point out that cast Misco starting at approximately 65,000 lb./o., meets the rolled curve at 1400° and is identical from that point up, showing that the beneficial working of the rolling is lost above 1400° F. As the welded bars were to be pulled at 1600° F. the two other materials were tested at only from 1400° F. to 1800° F. Alloy N is 23% Ni. and 8% Chromium. Alloy L is 9% Chrome and 4% Aluminum. Alloy 93 is silicon chromium and alloy V is 9% Chrome, 1% Nickel.

We made up a series of bars, as outlined in the accompanying table, electrically butt welded and machined to test bar form. The symbols designate the various combinations. All bars were held 30 minutes at 1600° F. before starting the pull, which was at the slowest speed available on the standard tensile machine used.

Only four bars broke in the weld, and in all cases, one of the sections was the aluminum alloy, proving rather conclusively that this material is not suitable for butt welding, probably due to aluminum oxide forming in the weld.

The balance all broke, as might easily be deduced from the high temperature tensile curves, in the material weakest at 1600° F.



COMPLETE CURVE IS ROLLED MISCO
ALLOY N. IS 23% NICKLE & 8% CHROME
ALLOY L. IS 9% CHROME & 4% ALUMINUM

Fig. 6.

WELDED TEST BARS PULLED AT 1600 F.—Head

Bars Marked	Dia.	Max. Load in Pounds	Break Location
M-N	.374	700	In M (In holder)
M-N	.375	1450	In N
M-N	.375	1450	In N
Average		1200	
M-L	.375	840	In weld
M-L	.375	820	In weld
M-L	.375	800	In weld
Average		820	
L-V	.376	610	In V
L-V	.376	620	In weld
L-V	.375	600	In V
Average		610	
M-N	.504	1550	In N
M-N	.506	1310	In N
M-N	.505	1410	In N
Average		1423	
M-L	.506	940	In L
M-L	.506	800	In L
M-L	.504	920	In L
Average		886	
M-93	.505	780	In 93
M-93	.504	720	In 93
M-93	.506	800	In 93
Average		766	
L-V	.504	570	In V
L-V	.506	720	In V
L-V	.506	660	In V
Average		650	

KEY

Alloy M is MISCO
Alloy N is 23% Ni. & 8% Cr.
Alloy L is 9% Cr. & 4% Al.
Alloy 93 is Silico-Cromium
Alloy V is 9% Cr. & 1% Ni.

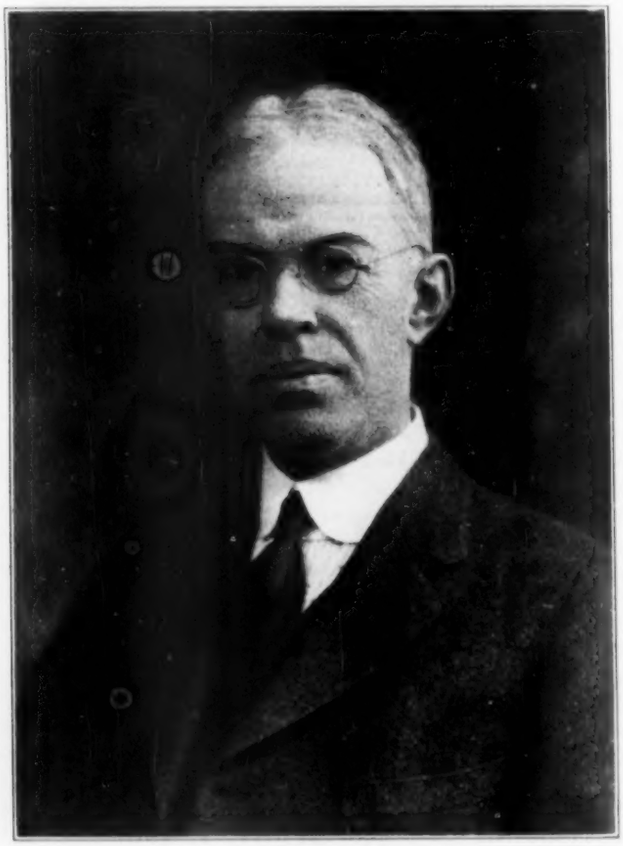
Several times we have encountered the problem of welding Misco to steel. Often times it is possible to save money on an apparatus by having Misco in the hot zone and steel welded to it in the cooler section. In several instances we have welded Misco skids on top of steel pipe. The Misco due to low heat conductivity keeps hot enough to avoid black spots on the billets passing over them.

The cheapest thing to use for this welding was steel welding wire, but we were unsuccessful in doing this work until we tried Misco welding wire. Welded test bars pulled in our laboratory show over three times the breaking strength in a Misco to steel weld using Misco wire than where steel wire is used.

We have never been able to deduce a satisfactory explanation for this solution except that perhaps less oxide is present in the weld when Misco welding wire is used.

S. W. MILLER

Samuel Wylie Miller, consulting engineer of the Union Carbide & Carbon Research Laboratories, Inc., of Long Island City, N. Y., well known both in the United States and in Europe as a pioneer in oxy-acetylene welding and an authority on its application, died on February 3rd at his home in Hollis, Long Island, N. Y., at the age of sixty-two.



Samuel Wylie Miller

Mr. Miller was a native of New York and received his degree in Mechanical Engineering from Stevens Institute in 1887. His first professional activities were as master mechanic for the Pennsylvania Railroad plants at Logansport, Indianapolis, Ind., and Columbus, Ohio. Following this he was with the American Locomotive Company at Dunkirk, S. Y., and Providence, R. I., after which he founded the Rochester Welding Works at Rochester, N. Y. During the World War he served on the Welding Committee of the Emergency Fleet Corporation. In 1921 he joined the newly formed Union Carbide and Carbon Research Laboratories, Inc.

In professional circles Mr. Miller was recognized as an able engineer. He was a director and past president of the American Welding Society, a director of the American Bureau of Welding and chairman of the Oxy-Acetylene Committee of the International Acetylene Association. As a member of the Welding Subcommitee of the Boiler Code Committee he was prominently identified with the American Society of Mechanical Engineers. He was an active member of the American Institute of Mining and Metallurgical Engineers, American Society for Steel Treating, British Iron and Steel Institute, Institute of Metals and other scientific and engineering organizations.

Mr. Miller was instrumental in the development of welding by all processes scientifically well founded and was noted for his energetic insistence upon high quality and dependable workmanship. He was the donor of the Miller Medal, awarded annually by the American Welding Society for work of conspicuous merit in advancing the art and science of welding.

He is credited with having been among the first to visualize the possibilities of the oxy-acetylene process and his important contributions to it were many. He wrote several books on the subject and was much sought after as a lecturer on welding at engineering meetings. The loss of Mr. Miller will be keenly felt by the entire engineering and welding profession.

(Note—The report of Mr. Miller's death arrived just after we had prepared for publication the excellent paper which starts on the next page. Like other contributions of his to the literature of the industry, this paper reflects an intensive study of the problems of the user of the process. Most of the papers from Mr. Miller's pen are as valuable today as at the time they were written.—Editor.)

INTERESTING STRUCTURAL WELDING JOB NOW UNDER WAY

According to a letter recently received from Mr. C. J. Holslag, of The Electric Arc Cutting and Welding Co., Newark, N. J., there is some interesting structural welding in progress in connection with changes being made on Bamberger's WOR building, Washington, Halsey and Market Sts., Newark, New Jersey. It appears that the new building is fifteen stories high and they are increasing the old one by strengthening all the columns from the foundation up, and joining these as well as the joints to the new building by arc welding, so that when it is finished the old building will also be fifteen stories high. Mr. Holslag states that this job will be under way for several months and offers his services to anyone who visits Newark and wishes to arrange to observe the work while it is in progress.

FOURTH MIDWEST POWER ENGINEERING CONFERENCE HELD IN CHICAGO.

Sponsored by local sections of nine national engineering societies, the fourth annual Midwest Power Engineering Conference was held at the Palmer House, Chicago, on February 12th to 15th. The Midwest Conference has been developed to consider in what ways the available power resources of the country may be best developed for the benefit of the people and the industries. At these annual conferences various phases of the power situation are outlined by able authorities, covering the specific and technical viewpoints as to what has been done and is being done in the power industry, considering also probable future developments.

Addresses on the subjects of power plant operaton, metallurgy, heating, ventilating and refrigeration, and electrical engineering problems were delivered by operating engineers and by university professors conducting research in these subjects. Fred G. Outcalt, of Linde Air Products Co., spoke on "Welding of Power Plant Piping."

In connection with the conference, an exhibition of power plant equipment, heating, refrigerating and ventilating equipment, power transmission machinery, electrical machinery and appliances, motors, devices for handling materials, and metal working equipment was held in the Coliseum.

Oxy-Acetylene Cutting Structural Steel*

Cuts in Important Places Should Be Made as Smooth as Possible—No Detrimental Effect on Steel Is Found—Sheared Surfaces More Subject to Cracking Than Torch Cut Surfaces

By S. W. Miller†

FROM time to time, there has been considerable discussion about this matter, and it is assuming increasing importance because of the very heavy sections that are now being used. A number of years ago, the heaviest standard section that was rolled was about 100 lbs. per foot, and the greatest thickness at any point was 1¼-in. at the root of the flange. Today, H-beams and columns are made of a weight two and one-half times as great, and the thickness is in some cases over 2-ins.

For medium weight sections, it has been possible to use shearing machines to do the coping, and it has been common practice to use hot or cold saws for cutting off ends of beams and other shapes, but with the advent of heavier sections, the design of coping machines became so massive and expensive that they are impracticable. Also, as oxy-acetylene cutting was used long before these heavy sections were produced, it is quite natural that this method of severing steel should be preferred for its cheapness, portability, ease of operation, and adaptability to any shape that it is desired to cut. This last advantage is of great importance because of present methods of design, which require such shapes as are shown in Fig. 1. Evidently, these forms could not be prepared by mechanical means without great expense, while by oxy-acetylene cutting they can be made with great ease, speed and economy of material.

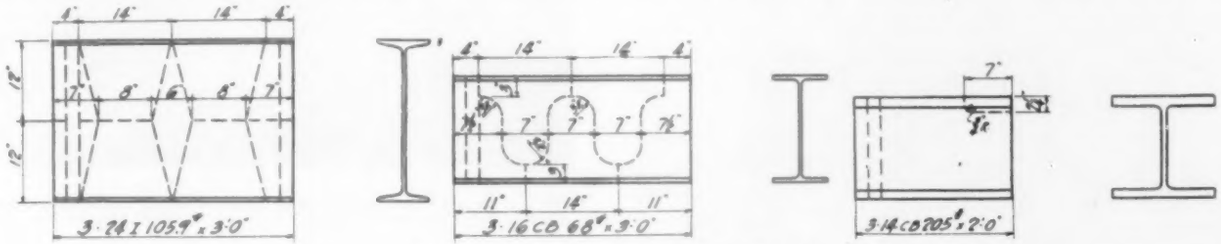


Fig. 1. Dotted Lines Indicate Flame Cutting.

There has been, however, some opposition to the oxy-acetylene cutting because of the supposed injury to the material by heat, although there has been presented no evidence, as far as the author knows, to prove that any damage has been done. For example, there have been a number of instances in which pieces that have been cut with the blowpipe have cracked, but there are many more cases in which similar pieces that have not been cut have cracked. It is, therefore, not fair to say, in such cases, that the cutting is the cause of the trouble, and certainly the cracks cannot be accepted as proof of the statement.

It is well known that shearing or punching distorts the metal at the edge of the shearing surface or at the hole, and initiates cracks. In important work, such as boilers, it is forbidden to punch greater than a certain thickness, and even then it is required that the holes be reamed to remove the damaged metal. In thicknesses above the limit, drilling must be used.

In the thinner sections of structural steel, it is common practice to punch the holes and shear the edges, but in the thicker sections, or in any case where the thickness of the metal is greater than the diameter of the rivet, drilling is employed. In fact, many specifications require that in important cases the holes must be drilled.

It is common knowledge that even minute cracks or sharp corners in steel lead to fatigue failures, such as are shown in Fig. 2. The effect of a sharp notch is also shown in Figs. 3 and 4 of a test piece that started to neck down, as shown, but shortly afterwards broke suddenly through the slight defect shown in the enlarged view. Fig. 5 shows the distortion of a sheared edge, and Fig. 6 shows the cracks that have been started by the shearing. It might be mentioned that in order to avoid these cracks it is required in boiler construction that caulking edges shall be planed, milled or chipped.

When oxy-acetylene cutting is done by a careless or inexperienced operator, the face of the cut will not be smooth as when the work is done by a machine driven blowpipe or by a more experienced operator. There is, however, no cracking in structural steel so cut, and even in the rough cuts the angle at which the cut surface will bend is greater than that to which a sheared surface will bend.

To show the effect of different kinds of oxy-acetylene cuts, a number of specimens were prepared from ⅜-in. steel plate and in the following structural shapes:

24-in. I-beam weighing 105.9 lbs. per ft.

16-in. beam weighing 68 lbs. per ft.

14-in. column weighing 205 lbs. per ft.

The chemical compositions of these steels were as follows:

Element	Steel Plate	24-Inch Beam	16-Inch Beam	14-inch Column
Carbon, per cent	0.22	0.20	0.12	0.20
Manganese, per cent	0.37	0.52	0.48	0.71
Silicon, per cent	0.01	0.02	0.03	0.03
Sulphur, per cent	0.031	0.037	0.045	0.038
Phosphorus, per cent	0.040	0.035	0.016	0.039

It will be seen that these results are entirely normal.

Bend Tests

The specimens for the bend test were taken from the ⅜-in. plate, the webs of the three beams and from the flange of the heaviest beam, so that the depth of cut ranged from ⅜ in. to 1½ in. They were bent by squeezing in a vise or pressing in the tensile testing machine until they were either flat or cracks had been started.[1] Some were milled, some were oxy-acetylene cut by machine, and others were oxy-acetylene cut by hand. Part of the hand cuts were made carefully to produce an even surface, while others were quite irregular and not representative of satisfactory work. The results are recorded in Table I, and the specimens after testing are shown in the photographs.

In Fig. 7 the left-hand specimen is a piece of boiler plate machine cut, the one at the right having had the surface milled. There is no crack in either specimen.

Fig. 8 shows a piece cut from the web of an I-beam ⅝ in.

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*Paper read before the 29th Annual Convention of the International Acetylene Association, Chicago, November 15, 1928.

†Research Engineer, Union Carbide and Carbon Research Laboratories, Inc., Long Island City, N. Y.

[1] Increasing the Utility of the Bend Test, by A. B. Kinzel. The Iron Age, September 6, 1928.

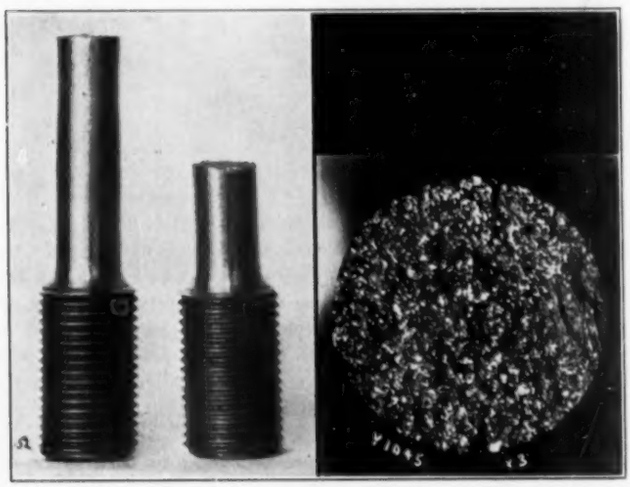
thick, the left one being machine cut, and the right one milled. It will be noticed that there are slight cracks in both.

Fig. 9 shows specimens from the web of a 14 in. column about 1 in. thick. Again the left specimen has been cut with a blowpipe,

Fig. 2. Sharp Corners and Minute Cracks Lead to Fatigue Failures.

and the right one milled. There are slight cracks visible in both cases.

Figs. 10 and 11 show similar specimens taken from the flange of the 14-in. column in a thickness slightly over 1½ in. The cracks are of the same order of magnitude in both cases.



Figs. 3 and 4. Sharp Notch Caused Sudden Failure. Defect May Be Seen.

Fig. 12. ⅜-in. plate. On the left, fairly smooth hand cut. No cracks. On the right, rough hand cut with slight cracks.

Fig. 13. Web of 16-in. I-beam about ½ in. thick. Average hand cut. No cracks.

Fig. 14. Web of 24-in. I-beam ⅝ in. thick. On the left, fairly smooth hand cut. On the right, rough hand cut. Small cracks in both.

Fig. 15. Web of 14-in. column about 1 in. thick. Left, smooth hand cut. Right, rough hand cut. Small cracks in both.

Fig. 16. Flange of 14-in. column about 1½ in. thick. Average hand cut. Crack just started on the edge.

Fig. 17. Same as Fig. 16, except machine cut on both sides. This specimen stood much more bending than the one shown in

Fig. 5. Section Through Sheared Edge Showing Distortion of Metal as Indicated by the Curved Lines. A Crack in About the Middle Edge Is Clearly Visible.

Fig. 16, and only developed a slight crack some distance back from the cut edge.

These photographs show clearly the advantage of smooth cutting over rough cutting, but they also show the superiority of even rough cuts to sheared edges, in that the cracks in the latter are much worse.

Before the bending, the specimens were marked at the center with 1-in. gage marks, and the elongation was calculated by measuring the distance between th marks on the curved surface after bending and dividing the increase in length by the original length. The results were checked by the bend extensometer, an instrument

TABLE I—BEND TEST DATA.

Material	Specimen No.	Thickness	How cut	Elongation per cent in 1" gage length
⅝" steel plate	22	.385"	Milled	60
⅝" steel plate	19	.382"	Mach. blowp.	59
⅝" steel plate	20	.385"	Hand blowp. smooth	56
⅝" steel plate	21	.386"	Hand blowp. rough	50
16" CB 68 lb.	6	*.450"	Hand blowp. smooth	58
16" CB 68 lb.	5	*.445"	Hand blowp. rough	58
16" CB 68 lb.	7	*.450"	Hand blowp.	..
24" I 105.9 lb.	2	*.628"	Milled	53
24" I 105.9 lb.	1	*.628"	Mach. lowp.	54
24" I 105.9 lb.	3	*.630"	Hand blowp. smooth	52
24" I 105.9 lb.	4	*.625"	Hand blowp. rough	51
14" CB 205 lb.	10	*.988"	Milled	44
14" CB 205 lb.	11	*.988"	Mach. blowp.	38
14" CB 205 lb.	8	*.992"	Hand blowp. smooth	43
14" CB 205 lb.	09	*1.00"	Hand blowp. rough	34
14" CB 205 lb.	14	†1.561"	Milled	49
14" CB 205 lb.	12	†1.561	Mach. blowp.	49
14" CB 205 lb.	13	†1.559	Mach. blowp.	47
14" CB 205 lb.	18	†1.560	Mach. blowp.	70
14" CB 205 lb.	16	†1.564	Hand & mach. blowp.	50

*Web. †Flange.

Specimen No. 7 was .45" thick; No. 16 and No. 18 were 1.56" thick; all others were about ⅝" thick.

Specimens No. 7, No. 16 and No. 18 were bent so that the cut face was on the side of the specimen with top in tension and bottom in compression; all others were bent with the cut face on the outside of the curve.

Elongation values for specimens No. 16 and No. 18 were obtained with the bend extensometer.

similar to the oculist's dioptometer. The values set down give a quantitative comparison of the bending which occurred in specimens in a given group, but on account of variations in width or thickness, the different groups are not comparable with each other in every case.

Inspection of the results obtained shows that the elongation in

the bend test of specimens cut by the machine blowpipe and on the milling machine were the same. That of the hand blowpipe specimens was not quite as good, but the decrease was very little when the cuts had been carefully made.

Fig. 6. Cracks in the Sheared Edges After Bending. Note the Slight Amount of Bending Compared with Machine or Torch Cut Edges.

Tensile Tests

A. S. T. M. standard 1½-in. wide flat tensile test specimens were taken from the ⅜-in. thick steel plate, the .625-in. thick web of the 24-in. I-beam and the .965-in. thick web of the 14-in. column. Specimens were prepared on a milling machine and others from adjacent material by oxy-acetylene cutting. The blowpipe was guided mechanically to secure a smooth face. This was necessary to get accurate measurements of the width of the specimens. The results of the tensile tests are set down in the following table:

TABLE II—DATA OF PHYSICAL TESTS.

Specimen	Size	Yield point lb. per sq. in.	Tensile strength, lb. per sq. in.	Elongation in 2 in., per cent	Elongation in 8 in. per cent	Reduction of area per cent
14" Beam—						
Milled	1.390x.995	31,300	58,200	52.0	30.5	56.8
Blowpipe 1 ...	1.500x.995	36,100	60,300	48.5	27.0	51.8
24" Beam—						
Milled	1.465x.625	28,000	50,700	51.5	32.2	57.2
Blowpipe 1	1.540x.625	32,400	53,000	51.0	29.1	61.2
Blowpipe 2	1.520x.625	32,600	53,100	50.0	28.2	58.8
Steel Plate—						
Milled 1.....	1.505x.390	35,800	57,900	46.5	29.1	55.9
Milled 2.....	1.510x.390	35,700	57,300	45.0	27.5	64.8
Milled 3.....	1.510x.390	35,700	57,300	45.0	29.9	59.7
Blowpipe 1	1.545x.385	39,000	58,800	48.0	28.9	60.8
Blowpipe 2	1.570x.385	38,900	59,600	44.0	27.0	64.7
Blowpipe 3	1.539x.385	37,850	56,900	48.0	27.8	67.5

It will be noticed that the yield point has been increased to the extent of about 4,000 lbs. per sq. in. for the oxy-acetylene cut pieces, and that the other properties were not appreciably changed. So that not only is there no injury to the tensile properties by oxy-acetylene cutting, but since it is the yield point that marks the beginning of failure, the increase in it, secured without reducing the ductility, is quite advantageous.

Machine Cutting

In order to obtain smooth cuts, it is advisable to use some type of machine which guides and moves the torch. Such a machine is shown in Figs. 18 and 19. It is shown cutting the second piece in Fig. 1. These pieces and others of generally similar outline are used for brackets for wind bracing in steel frame buildings. Large numbers of these brackets are used, and the designers wish to have the fillets cut smoothly in order to avoid the notch effect referred to previously.

Fig. 20 shows the templets used in cutting the two shapes in Fig. 1, and Fig. 21 shows the smoothness and accuracy of the cut in a partially finished piece. The entire beam is passed through the machine, and after the cut shown in Fig. 21 is made, it is turned up on edge and the flanges cut at the proper places. It is also possible to provide a separate cutting torch that will cut the flanges at the same time that the rest of the cut is being made, so that the beam does not have to be turned or moved.

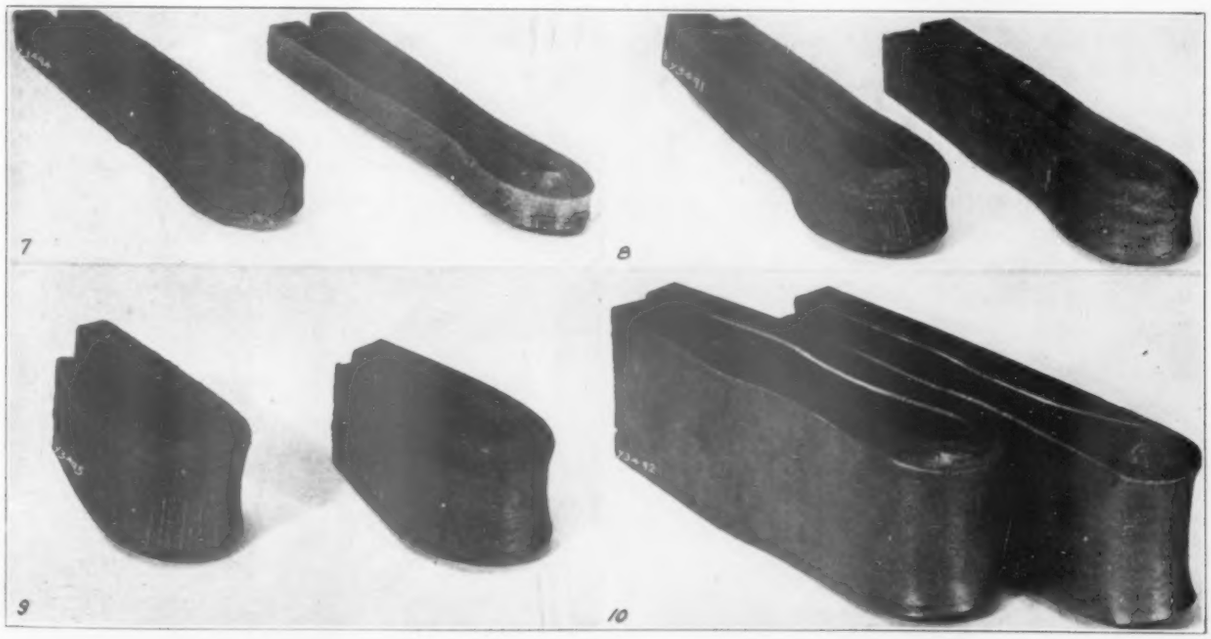


Fig. 7. Left: Cut in Boiler Plate. Right: Milled Surface. No Crack in Either.
Fig. 8. Specimen from Web of I-Beam. Left: Machine Cut. Right: Milled. Slight Cracks in Both.
Fig. 9. Slight Cracks Show in Specimens from 14-in. Column.
Fig. 10. Similar Specimens from Flange of 14-in. Column.

Macro and Microstructures

These have been referred to a number of times before.

Investigation of the Effect of Torch Cutting Forge Steel, by J. R. Dawson, published in the Acetylene Journal for February, 1923.

The effect of Heat on Steel, Especially During Fusion Welding and Cutting, by S. W. Miller. American Welding Society Journal for September, 1925.

What Occurs During the Oxy-Acetylene Cutting of Steel, by S. W. Miller, published in the American Welding Society Journal for December, 1925.

In none of these cases, however, has structural steel been considered, so that in Figs. 22, 23, 24, and 25, the effect on structural steel is shown. As the carbon content of this type of steel is in the neighborhood of .2 per cent, it would not be expected that the heating and cooling effect would be as great as in steels of higher carbon content, and this has been found to be the case. While there is a slight increase in the carbon content for a short distance, less than .01 per cent back of the face of the cut, it is not sufficient in amount to make the steel brittle or give more than a slightly increased hardness, judging from the microstructure alone. This conclusion is confirmed by the ductility of the metal under the bend test.

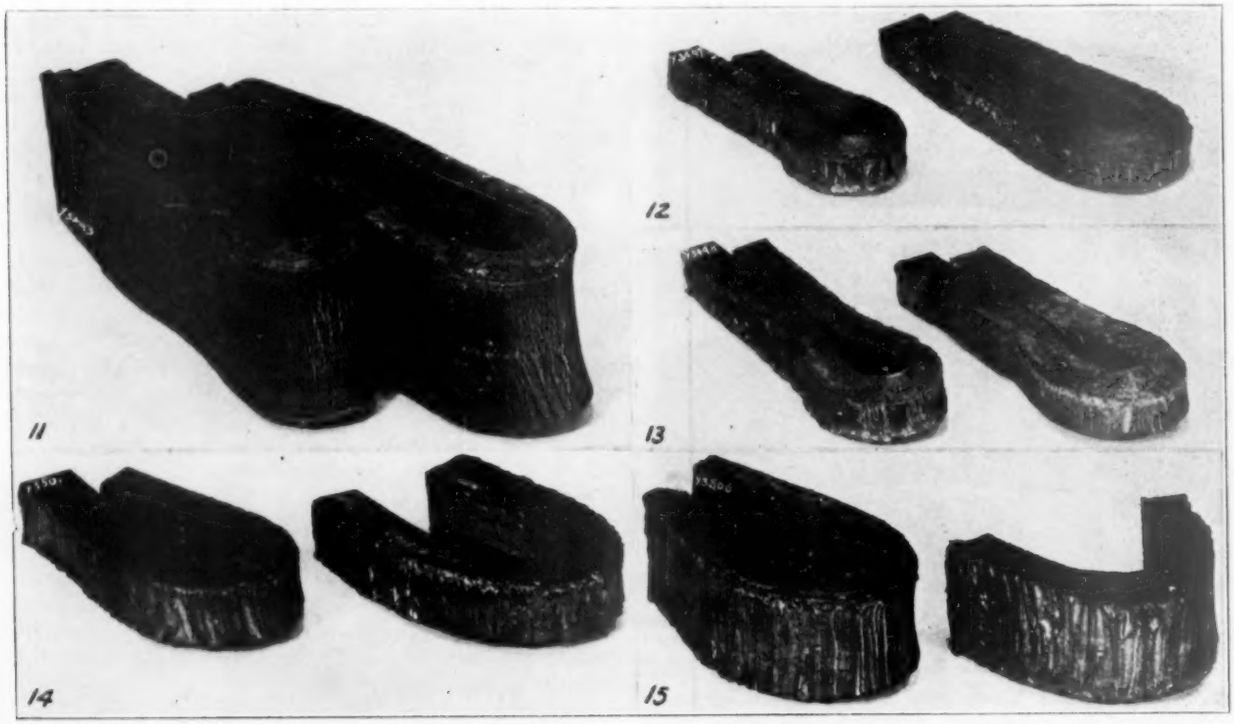


Fig. 11. Specimen from Flange in 14-in. Column.
Fig. 12. Smooth Hand Cut on Left Shows No Cracks. Rough Cut on Right Shows Slight Cracks.
Fig. 13. Average Hand Cut in ½-in. Shows No Cracks.
Fig. 14. Small Cracks in ⅝ in. Material. Average Hand Cut and Rough Hand Cut.
Fig. 15. Smooth and Rough Hand Cuts Both Show Cracks in Material About One Inch Thick.

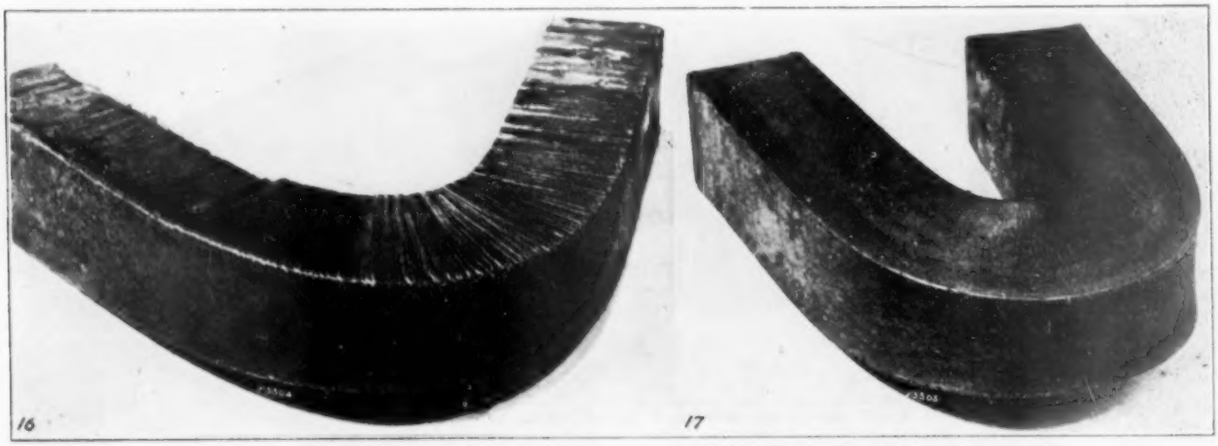


Fig. 16. Average Hand Cut in Flange of 14-in. Column. Crack Just Started on Edge.
Fig. 17. Same as Fig. 16 Except Machine Cut on Both Sides. Only Slight Crack Some Distance from Cut Edge.

Conclusions

All oxy-acetylene cuts in important places should be made as smooth as possible.

Structural steel cut by hand is not damaged in the material itself, but if the cut is irregular, the notch effect of the irregulari-

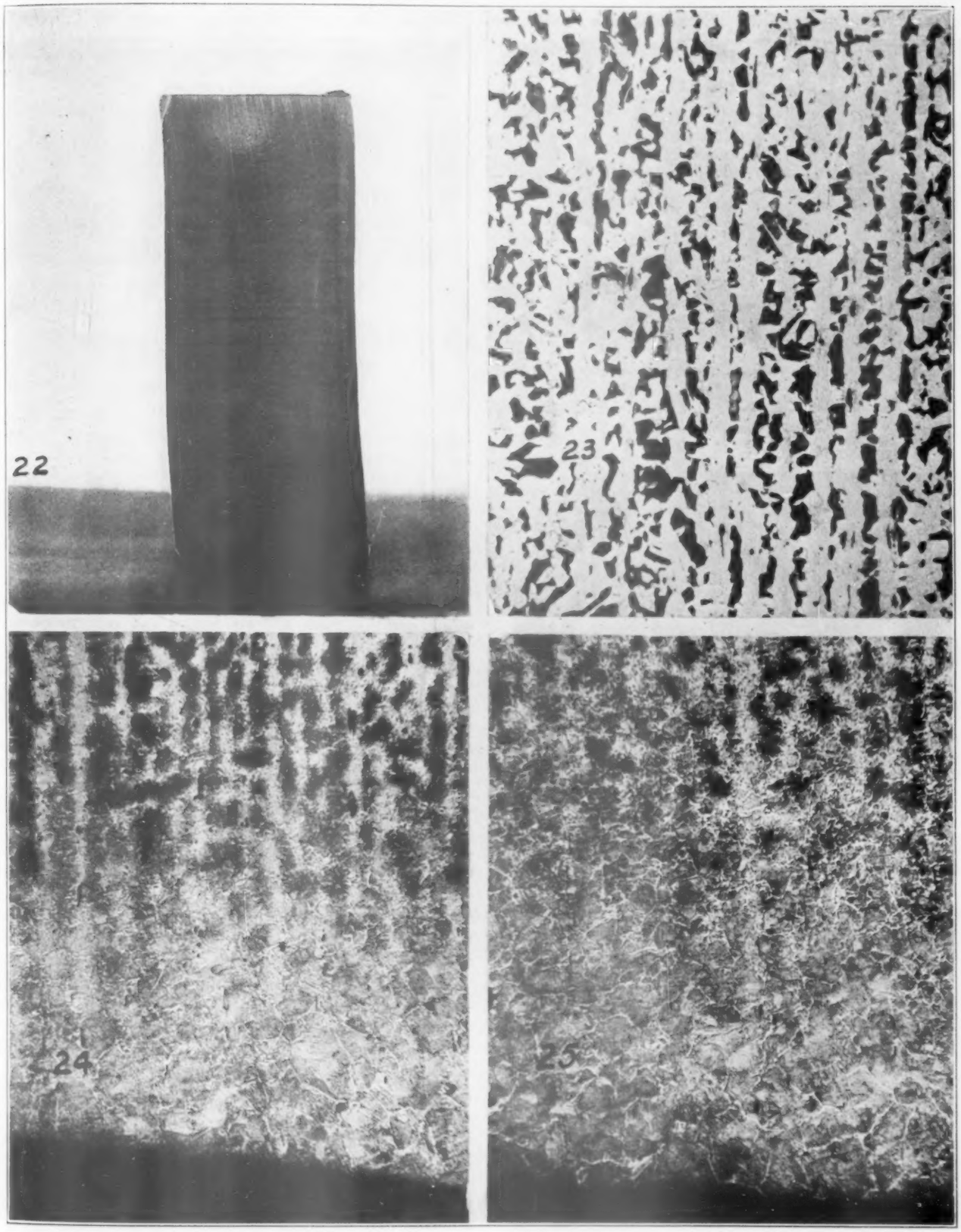


Fig. 22. Macrophotograph of polished and etched torch cut edge in 1¼ in. plate. The torch cut face is at the right, and the maximum heat effect, shown by the discoloration, is about .05-in. X2.6. Fig. 23. Original structure of structural steel 1¼-in. thick, containing about .2% carbon. X100. Fig. 24. Structure at the top of oxy-acetylene cut edge. The effect of the heat extends for about .04-in. back from the face, but no increase in carbon has taken place further back than about .01-in. The structure indicates that the amount of carbon at the face is not over .4%. X100. Fig. 25. Structure at the bottom of the edge. The heat effect has extended in a trifle further, but there is no noticeable difference in the amount of carbon from that in Fig. 24. X100.

ties will start cracks under the bend test somewhat sooner than when the surface is machine cut or machined.

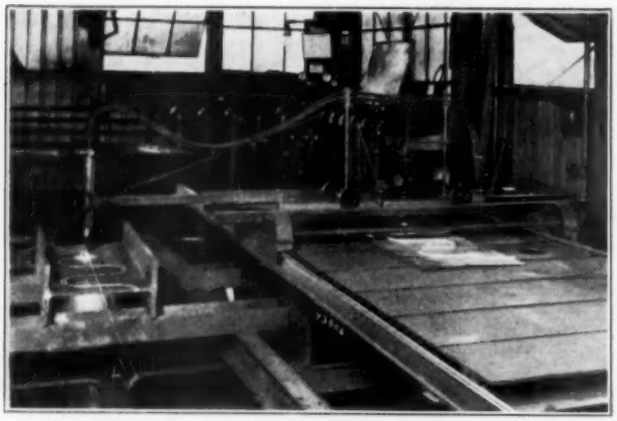


Fig. 18. Machine-Driven Cutting Torch Produces Smooth Cuts.

There is no noticeable difference between smooth machine cuts and surfaces milled or otherwise smoothly machined.

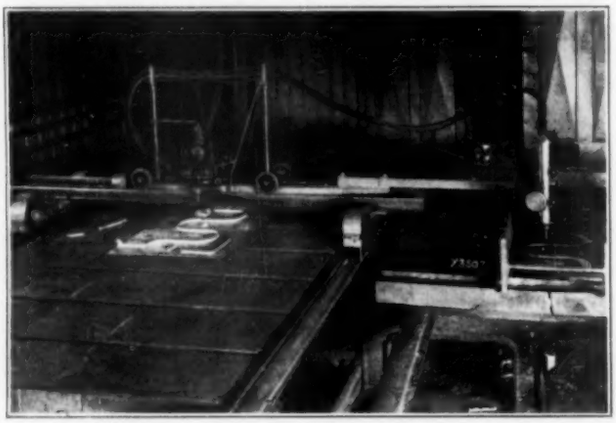


Fig. 19. Machine Cutting Second Piece Shown in Fig. 1.

Sheared surfaces are much more subject to cracking than are those cut in any way by the oxy-acetylene torch.

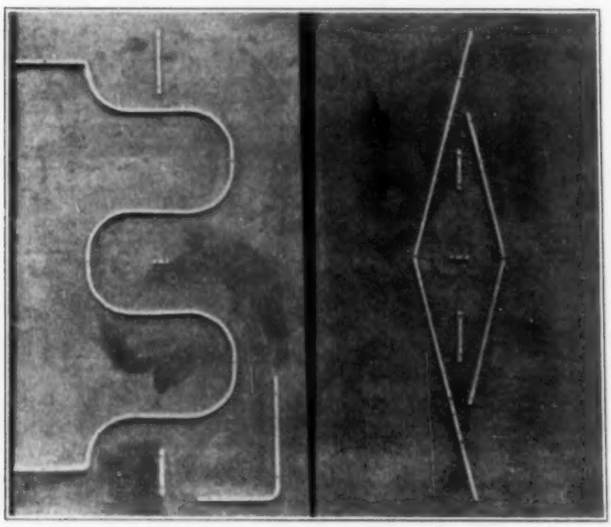


Fig. 20. Templet for Machine Cutting.

Marco and microstructures show that the heat effect of oxy-acetylene cutting on structural steel is negligible, and the physical tests show that the effect produced is advantageous rather than detrimental.

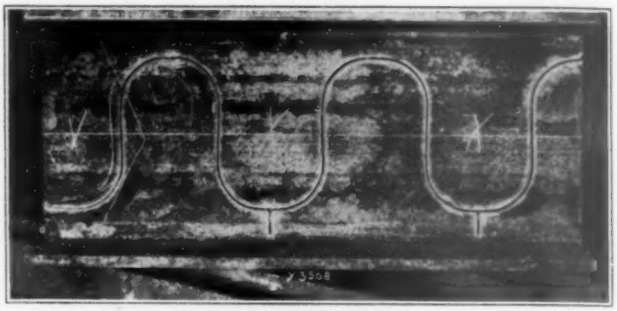


Fig. 21. Smooth Accurate Cuts Are Machine Made.

HEAT TREATMENT WILL IMPROVE AIRCRAFT STRUCTURE

By J. F. Hardecker*

The welded steel fuselage is the accepted standard of aircraft construction today. This is usually fabricated by welding of chrome molybdenum steel tubing, which, without subsequent heat treatment, gives a strength of 95,000 pounds per square inch. Its advantages have been too well established to warrant further discussion here.

In the case of wing beams, however, designers have for years sought a way to use steel of high strength in place of wood. They recognized the advantages to be gained in lightness as well as in strength, permanence, reliability, uniformity, fabricating qualities, crash and fire hazard and adequate supply. The obstacle was that, without heat treatment, steel in a welded structure could not be counted on for more than 95,000 pounds per square inch. Designed to such figures, steel wing beams were too heavy, and no means existed for heat treating these long, straight, delicate members to the high tensile strength required for lightness, without prohibitive distortion and other troubles.

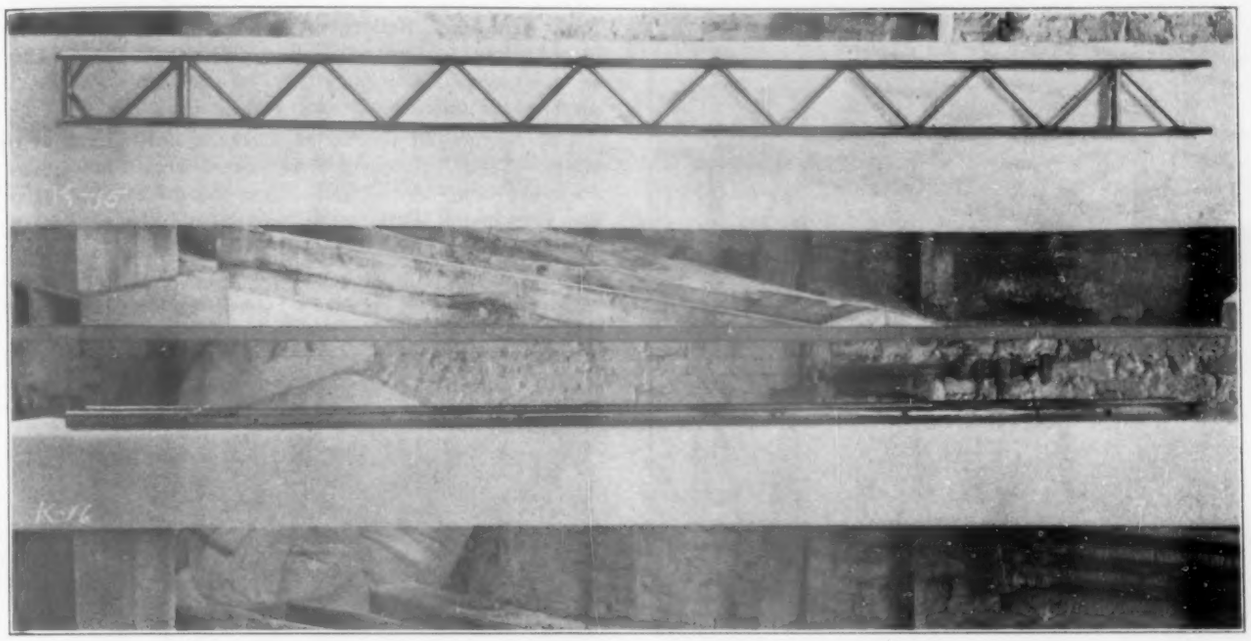
So, wood continued as the principal material in aircraft wing beam construction. In the all metal plane, duralumin (an aluminum copper alloy with the strength of mild steel at about one-third the weight) was employed. Duralumin, however, has to be heat treated to attain this strength, and must be worked within an hour or two of its heat treatment, before it hardens. This coupled with the fact that present fabrication must resort to many small rivets similarly heat treated, since the successful structural welding of duralumin is not as yet a shop process, left duralumin as a satisfactory engineering material but with much to be desired from a production fabrication viewpoint.

So we find the situation, until the recent demonstration of successful heat treating of welded steel wing beams by the Metallurgical Laboratories of Philadelphia, Pa. Figure 1 shows a wing beam which has been successfully heat treated. It is constructed of chrome molybdenum steel tubing, assembled by welding, and carefully designed to obtain a high strength-weight efficiency in the heat-treatment structure. The longitudinal members are slotted to receive the diagonal members, thus eliminating all gussets, the entire structure being assembled by simple torch welding. The beam shown is 10 feet long and weighs 14 pounds. The deformation from heat treatment was less than $\frac{3}{16}$" in 10 feet (see Figure 2), which is considered neglible. Physical properties not only ex-

Chief Draftsman, Naval Aircraft Factory, Philadelphia.

ceeded specifications, but tests made along the length showed remarkable uniformity.

A view of the special heat treating furnace that has made this possible is shown in Figure 3. Its significance as ushering in a new era in aircraft construction cannot be emphasized too



Figs. 1 and 2. Welded Steel Wing Beams Successfully Heat Treated.

greatly. The aircraft industry is quickly changing from wood to metal construction, and both of the chief metals used, steel and duralumin, require heat treatment. The parts used in airplanes that need to be heat treated, are usually of such a shape and size that the ordinary commercial heat treating equipment is inadequate in size and handling facilities. Heat treating fur-

Fig. 3. The Heat Treating Furnace of the Metallurgical Laboratories, Inc.

naces ordinarily used are horizontal, but this new furnace is vertical. This means that long tubular parts can be suspended in it, and can be lowered vertically into the quenching tank of proper depth, directly beneath the furnace. This automatic electric furnace has a heating chamber 25 feet high and 2 feet in diameter, expressly designed for the heat treatment of welded steel beams for aircraft.

While this may seem like a new event in heat treating, it is of primary importance to the welding industry. It means that within the capacity of this furnace, the structural strength of welded steel aircraft units has been more than doubled. To the airplane manufacturer, it means the opportunity to use the best fabrication method from a production viewpoint, which is of course welding, at less than half the current weight in a properly designed structure. This tremendous weight saving may be converted into increased fuel capacity, which means greater range without refueling, or increased pay load (passengers, mail or express) without increased engine capacity or plane size. This new furnace of the Metallurgical Laboratories, Inc., has greatly advanced the cause of welding in aircraft work and its possibilities in other industries employing welding are extremely significant. Its effect on welding applications may well be revolutionary.

TO SOLVE PROBLEMS IN OXY-ACETYLENE WELDING

The Oxy-acteylene Committee of the International Acetylene Association extends to the users of the oxy-acetylene welding and cutting processes an invitation to call on the Association during the year of 1929 for advice on how to get the most out of the processes at the least possible cost. Many of the difficulties, it is felt, have been solved for someone else in a similar line, and if they have not, somewhere in the organization is a man who can help. Interested individuals are invited to write to the Association for a copy of the Oxy-acetylene Committee Report for 1928. It contains a comprehensive review of many interesting subjects pertaining to the use of these processes. Address the International Acetylene Association, 30 E. 42nd St., New York, attention the Oxy-acetylene Committee.

A new Prest-O-Lite Acetylene Plant, at 1241 North McLean Boulevard, Memphis, Tenn., commenced operations December 19, 1928. This plant, which is the thirty-sixth of the Prest-O-Lite chain, will supply nearby industries with dissolved acetylene for oxy-acetylene welding and cutting. J. Brown is superintendent of the Memphis plant and C. A. Anderson, whose headquarters are at Birmingham, is district superintendent.

LARGE FOOT BRIDGE CONSTRUCTED BY WELDING

A foot bridge 846 feet long, for the convenience of employes of the General Electric Company's plant at Schenectady, was recently constructed by electric arc welding.

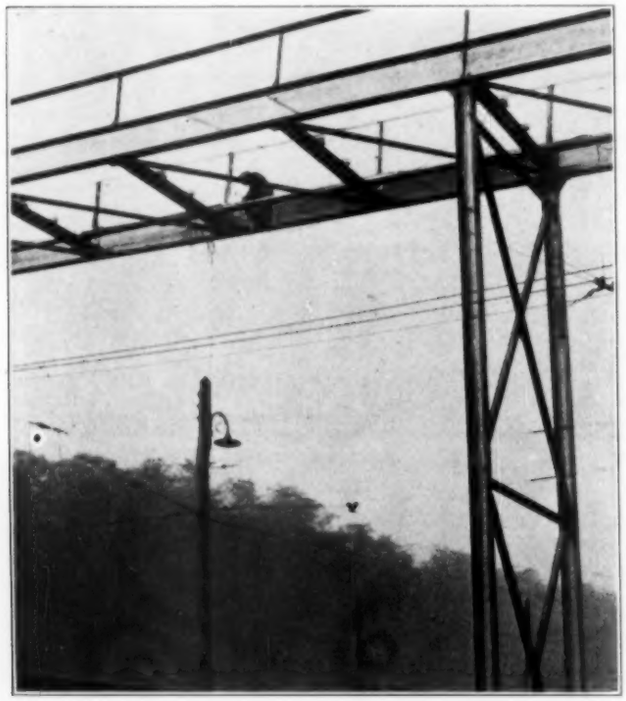


Fig. 1. View at One of the High Spans Showing Welder at Work.

This bridge, containing 105 tons of steel, extends over the Delaware & Hudson Railroad tracks to a nearby hillside.

Beam and girder construction is used. A total of 20 spans is involved, varying in length from 20 to 60 feet. The bridge

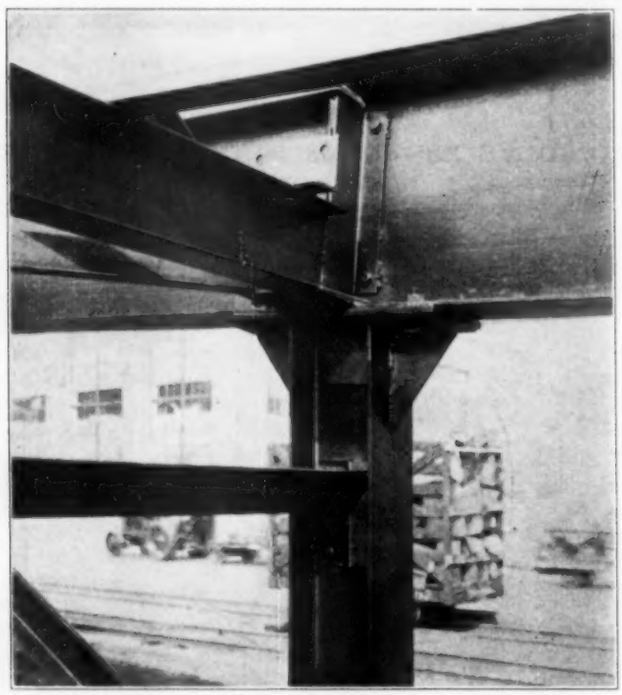


Fig. 2. Close-up of Intersection of Girder, Column, and Floor Beam, Showing Details.

rests on towers and "bents" (or posts) principally the latter, three towers being used at the highest points for bracing purposes. A total of 14 bents supports the remainder of the structure.

Two sizes of girders are employed, both Bethlehem shapes: one is 22 ft., 58 pounds per foot, and the other is 30 ft., 110 pounds per foot. These form the bridge stringers. The columns are 10-8 Bethlehem H sections, 33½ pounds per foot, varying height from six to 37 feet—an 8% grade. The floor beams are 8-inch Bethlehem I-beams, 17½ pounds per foot, spaced every 10 feet on centers. Floor planks are laid on wood stringers. Bracing angles for the bents vary in size, but most of them are 4x3x¼ inch stock.

Near the ground the bridge makes a turn almost at right angles. Near the upper end is located a gate house. From the lower ramp to the gate house the distance is 571 feet. The gate house is 20 feet in length, and the distance from the gates to the upper end is 255 feet.

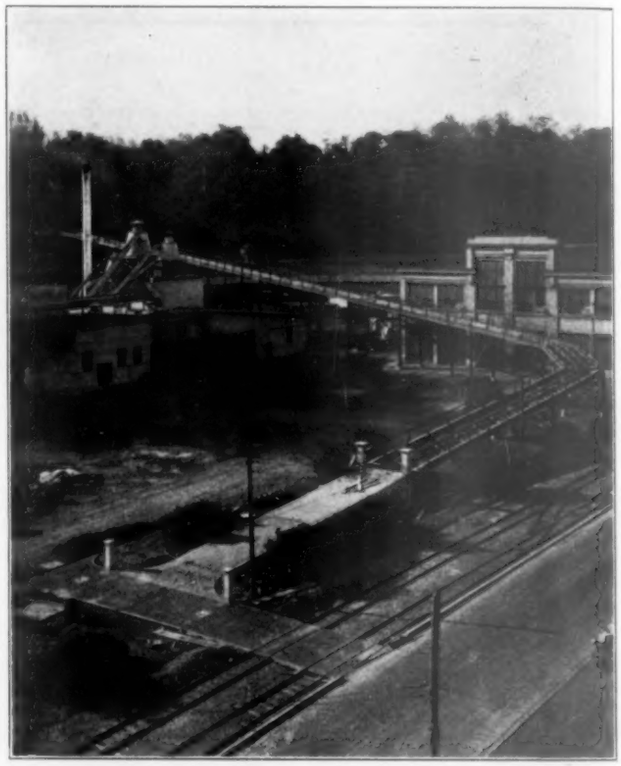


Fig. 3. General View of Bridge Structural Work Completed, Before Flooring Was Laid.

Electric arc welding was used throughout, utilizing General Electric equipment. The shop welding was done in the plant of the Williams Bridge Company of Syracuse, N. Y., while the field welding was done by the General Electric Company using a Fordson tractor-welder rated 300 amperes and two resistors supplying current from an overhead trolley line. The welds were of the fillet type, ⅜" in size, and the three operators used about 225 amperes at each arc with G. E. type F. electrode.

This viaduct, now in use, affords a foot path 12 feet in width and well lighted throughout its length. There are also two ornamental light standards on the lower approach. For safety purposes there is a 1½-inch double pipe hand rail along each side of the runway, and this is supplemented by a steel mesh 24 inches high.

The regular monthly meeting of The Victorian Institute of Welding Engineers was held at the Ford Manufacturing Company's Works, Deelong, Victoria, Australia, on Thursday, January 24th, at two o'clock, the subject of discussion was "The Application of Welding by Workshop Operators."

Selling Quality Welded Tanks

How One Welding Shop Manager Has Increased His Business and Profits by the Use of Abstraction in His Sales Campaign

By J. D. Tierney*

Four years ago we decided to seek and encourage some business on all welded tanks. Like most job welding shop owners, our facilities were limited to the cutting torch, the oxy-acetylene welding torch and the electric arc and metallic arc welding units.

Established Competition Was Well Equipped

With these limited facilities, it did not seem to us, in the beginning of things, that we had very much chance to compete with established tank fabricators whose plants and factories were well equipped with alligator shears, one stroke shears capable of cutting ten to twelve feet of ¼" plate in less than two seconds with one blow of the shear blade, and rolls of the type in which a vee block can be used to form bend a ten foot plate of ⅜" thickness to 90 degrees in about two minutes, when it would require about one and one-half hours to weld a heavy reinforced type of joint of the same length and same thickness of material. There was also the breaking machine of heavy capacity design to compete with, when it could form bend long corner joints even faster than the roll and vee block.

The Welding Shop's Advantage

There seemed to be two hopes on which we had a chance. One was the fact that we could torch cut as fast as our competitor and we could also weld as fast, if not a little faster than the other fellows who did not have their hands in welding continually without intermission. The other hope was the fact that our overhead did not amount to as much as the well equipped competition, which would aid us in reaching a price figure in close proximity to general prevailing prices.

These two hopes were an encouraging urge and we decided to study the practices of tank fabricators.

While our survey was being made, we purchased and maintained a small stock of commercial steel and found it kind of hard to meet competitive prices. Try as we might, we could not seem to create a demand for our extra heavy reinforced welded tank joints.

Surveying the Field

Six months of survey and gathering of facts taught us that tank makers follow very nearly in common with each other as to the materials used and the fabricating practices and workmanship employed. We learned that commercial steel plate, known as either "tank steel," "boiler plate," "boiler iron" and "ordinary steel" was the standard plate and in most cases was specified by tank buyers in their inquiries for price on their requirements.

Shop practices included the buying of commercial steel plate in adopted standard sizes of various dimensions. In some cases it was found that special sizes were purchased. However, in most cases the plate material cost all fabricators the same price, base plus extras. A few fabricators who stocked large quantities in carloads of a size had a little advantage over competition because of the volume and the additioanl small margin of profit realized on volume buying.

Procedure Fairly Uniform

Generally summed up, the shop equipment and fabricating facilities were about equal, with a fabricator here and there who had it on his competitor with reference to capacity of equipment and modern equipment versus the obsolete type which some few fabricators just wouldn't let go to the scrap pile.

All in all, the slight advantages, one tank maker had over the other did not count for very much on tank products which were built to specification. This article is not referring to the specialty tank makers who produce what we term the production tank, where tanks of the one specification are manufactured on a large volume basis and with specially designed machinery and methods for quantity production, unless a specialty tank maker would decide to use ABSTRACTION even in his special product. (Incidentally the author would advise it.)

A Study of Price Policies

Inquiries were directed to 26 fabricators to determine price variations. Specifications which were directed to these tank makers were of various kinds, some carelessly written, leaving room for various interpretations, and others clearly drawn and made important with directions which would allow for only one interpretation of the specification. In six months, at intervals of one to two weeks inquiries were mailed until 18 inquiries were sent and toward the latter end of the test, previous inquiries were duplicated.

The prices quoted were astonishing in some instances because there could be such a wide difference of price on the same specification. One time one maker would be higher than all the other bidders and he would be the lowest on a following specification. An analysis of the materials in pounds and the amount of cutting and welding required on the respective specifications would prove that there was no standard upon which prices were made. This proved doubly true when the repeat duplicate specifications were sent out and in no case did any of the tank makers submit the same price they submitted on the same specifications four months previously.

Price the Big Issue

Twenty-five of the fabricators made price the big issue in their proposals and one fabricator capitalized on quality, not of materials, but of workmanship. Seven fabricators had a follow up system of mail and two had a follow up by sales representatives. Sixteen tank makers did not use any follow-up methods to obtain business.

It was particularly noted that only one fabricator submitted a proposal of unusual interest. All the others were the same cut and dried "Referring to your inquiry of such a date, we propose, etc." and would usually conclude with some boast or brag about how thankful they were for the opportunity to submit and would *await* with interest, etc. The boast and brag in most cases was all about their company and the many years they were in business. Nothing was offered to the happiness of the one to whom the letter-proposal was addressed, excepting price.

So with these facts before us, we went into the tank business, with the idea in mind to sell "quality" and not "price." We planned that we would creep along slow but sure and later we would walk when our tank business legs were stronger.

"Quality" Selling Involve Education

We knew from our short experience with commercial plate tank selling, that most tank buyers did not know that there could be a great difference in one tank over another when the two tanks might be built from the same specifications and that we would have to educate the tank buyer to know these differences.

It was not going to be a case of just telling the tank buyer, of making claims and expecting him to believe our claims, unless we could prove it beyond question of doubt.

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We knew that the majority of tank buyers didn't know the real difference between erosion and corrosion. They proved it when they specified commercial steel in tanks which were not going to be subjected to erosion, but to corrosion.

Selling Pure Iron to Resist Corrosion

We knew that the elimination to a minimum of the impurities in steel, the manganese, silicon, sulphur, copper, phosphorus and carbon, brught the metal as near to pure iron as it is commercially possible to do it and that these impurity elements are the elements which are so readily attacked by corrosive elements.

We knew Armco Ingot Iron plate would outlast steel plate, under like conditions, at least one and one-half times, as it was guaranteed to us by the maker to contain not more than sixteen hudredths of one per cent aggregate impurities. THERE WAS AN ABSTRACT SELLING POINT ON THAT PROMISED US BUSINESS ON WHICH WE WOULD HAVE NO COMPETITION, IF WE HAD A STOCK OF THIS PLATE FOR IMMEDIATE FABRICATION AND DELIVERY IN THE TANK FORM.

We negotiated with The American Rolling Mill Co. for a minimum carload as our initial stock. With no great amount of tank business and very little tank customer contact established, this first carload seemed a very large stock because we were just the ordinary job welding company, progressing slowly, but surely, because we did our work of welding in the manner which satisfied those who entrusted work to us.

The First Sales Promotion Work

While the initial carload of Armco plate was in transit, we direct-mailed a series of letters to prospective tank buyers, telling them that this material would allow them at least one and one-half times the value they receive in commercial steel, for the same initial price, because their tank requirements were being purchased to stand the attacks of corrosion and not erosion, for which steel was the most suitable.

250 Tons in Fourteen Months

Our first carload, 18 tons, was ordered in November, 1927. At this writing in January, 1929, fourteen months later, we find we have turned over 250 tons of Armco Ingot Iron plate into Armco Ingot Iron tanks. From a working force of five employees, our little organization has increased to fourteen and the present demand for our tank products has us continually looking for additional metallic arc welding operators who can produce first class welding results on first class tank products.

There is nothing phenomenal about the establishment of this tank business and our facilities are still the cutting torch and arc-welding electrode of the same types used by most welding job shops.

Way down deep in our hearts, our selfish aim, if we might call it that, is to sell welding. Welding procedure control is the backbone of the job shop welder and a survey most anywhere in the country will prove that weding job shop owners are following the old rules of selling welding, welding, welding, when, it would pay far better to consider their welding a secondary issue, a thing they are bound to get, if they can better advertise and sell an abstract thing which carries merits and values that are not present in the concrete thing, the welding they do.

Advertising the Abstract Thing

Our advertising-selling on our tank business capitalizes on the merits of Armco Ingot Iron plate, with its corrosion resisting features. Our literature as well as our written correspondence and our follow-up letters, keeps pounding on the facts which proves to the prospective tank buyers that they can, for almost the same initial price, procure an Armco Plate tank which will represent one and one-half to two times the value they receive in commercial steel tanks because they are going to subject their tank to corrosive elements and Armco Ingot Iron Plate will resist corrosion.

Careful Welding Is an Incident

We do produce a quality weld, a heavy reinforced weld at all joints, not the hurried up type which is designed for speed-and-price-only issues, but we treat lightly and firmly on this weld subject, just the amount which assures the prospective tank buyer that our welding procedure control is designed for quality rather than price, because it would not pay to put hurried up welds on a "long-life-plate" as the welds must be designed to outlast the plate, thus giving the buyer a "one-cost" tank, an initial cost, free from future upkeep costs.

Every tank buyer is interested in cutting costs and increasing profits for his company and it behooves the job shop welders, any shop with a cutting torch and an arc welding unit, to get some tank business as an increased volume with increasing profits.

We will be glad to forward some of the literature we have used in establishing our tank business. This literature will be sent without charge to any welding job shop owner who will request it on his letterhead, as we are glad to offer any help we can to any move which will tend to progress the welding job shop business of our brother welder and ourselves.

(Note—While capitalizing on the "abstraction" of Armco Plate, Mr. Tierney hit upon some facts which have resulted in selling ***over 70,000 lineal feet of inside welding*** *in addition to the outside welding of tank joints in these last fourteen months. He has generously agreed to give us the complete facts on this subject for publication in a future issue.—Editor.*

CHICAGO SECTION DISCUSSES ORGANIZATION OF WELDING DEPARTMENTS

On the night of Friday, February 1st, the Chicago Section of the American Welding Society held its regular monthly meeting in the auditorium of the Engineering Building. A motion picture of two reels entitled "The Story of Cork" was shown as the first part of the program. This was followed by the presentation of a paper by Mr. H. M. Downing of The Lincoln Electric Co. The paper discussed the principal factors necessary for the establishment of a practical and efficient welding department in the modern manufacturing plant. This was followed by general discussion in which a number of the most important points were emphasized again. The meeting was concluded with the showing of a recent film made by the Lincoln Electric Co. entitled "Modern Manufacturing with a Stable Arc Welder." This depicted the manufacture of arc welded steel products, showing their advantages over cast or riveted construction, and suggested how this process can be used to advantage in any plants manufacturing products of weldable materials.

NEW USE OF ACETYLENE IN THE NAVY

In the Navy and Mercantile Marine it is understood that water tanks must be lined with one or another of certain approved materials which are like pitch and must be applied hot to the walls of the tank. It cools and sets so quickly that the only way to do the job is to put it on in lumps and heat them in position until they spread. Until recently this was done with a blow lamp, but the great heat provided by a high temperature air-acetylene brazing tool has now been found to be better than the old method, both as to speed of work and cost.

The M. E. Canfield Co., 316 Commercial St., Los Angeles, California, will handle a complete stock of all grades of Raco Welding Wires, as they have now become the Pacific Coast Representatives of The Reid-Avery Co. of Philadelphia, Pa.

Design of Welded Joints for Aircraft*

One of the Important Problems in Aircraft Fabrication Is the Selection of the Proper Joint Design for Different Parts of the Airplane

By J. B. Johnson

Chief, Materials Unit, Wright Field, Dayton, Ohio

PART I

THE airplane structure is built up of a large number of parts and a rapid, economical method of joining these parts is essential. Several mechanical and thermal processes, such as riveting, pinning and bolting, soldering, brazing and welding, have been advocated by different constructors and used with varying degrees of success. The process of welding has been in competition with these other methods since the construction of the first airplanes. The welding on some of the first sheet-metal fittings was very crude, however, and did not warrant the confidence of the engineers. The application of welding in several industries has forced the development of small, light-weight equipment,

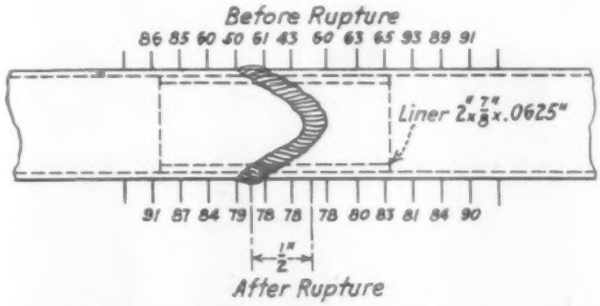


Fig. 1. Readings Taken Before and After the Rupture of a Weld in Tension.

increased the facilities for distributing raw materials, and produced a body of mechanics who are skilled in handling an oxy-acetylene torch. The low cost of plant equipment and the ease with which joints could be made in thin metal without elaborate designs or expensive jigs could not be overlooked by the aircraft industry. The advantages of a rigid metal framework were recognized and added further impetus to the use of welding.

The total production of aircraft in this country in 1921 was 302 airplanes. These were practically all typical wooden structures. In 1927 the production was 2353 airplanes, and it has been estimated that this year the production will be from 4,500 to 7,000 aircraft. The latter figure probably more nearly represents the actual production. Approximately one-fifth will be for the Army and Navy. The remainder are commercial aircraft. Ninety per cent of these modern airplanes will have oxy-acetylene welded steel fuselages, landing chassis, tail skids, and fittings.

Problems Involved in Design

The factors which have led to the increase in the use of oxy-acetylene welding in preference to other methods have been stated. The confidence of designers and constructors in the reliability of welding evolved as a result of improvement in design and the eminently satisfactory service obtained with the first welded fuselages or bodies.

The airplane is essentially the product of the engineer and must satisfy the most exacting requirements as to strength and reliability. The improvement in design has been brought about by laboratory tests, metallurgical analysis, and the usual process of trial and error. The simplest type of joint is a splice, joining two parts. The method of making these splices in sheet metal has been developed for several types of engineering structures, and the designer of the airplane has simply adopted these methods without much modification. The metal is thin and it is seldom necessary to bevel the edges.

In the case of the thin-walled, seamless, steel tubing, methods of splicing have been developed by the aircraft industry. In table I are given the values taken from an average of about 50 tests representative of the strength of a butt splice. These figures would be different for any combination of data which might be compiled, but the average figure as given in this table should be obtained by any welder competent to weld aircraft parts. The minimum and maximum simply represent the limiting values which are to be expected when testing splices prepared by various welders. The tension test does not always show the true

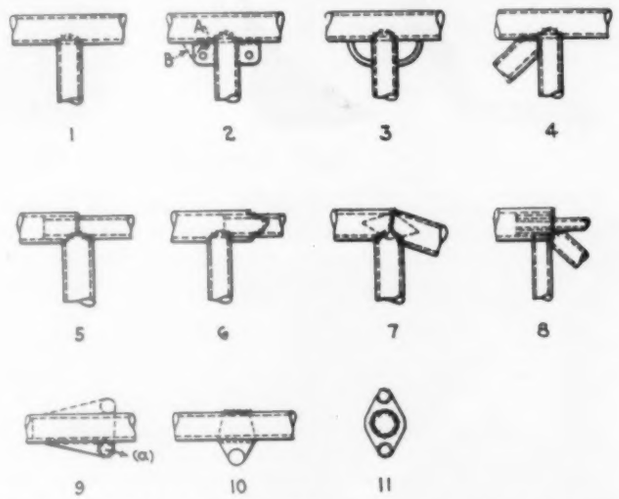


Fig. 2. Welded Joint Designs Which Have Been Used Satisfactorily.

weakness of a joint, as the metal close to the weld which has been softened by the heat of the welding flame will strain-harden during the test and may give a value higher than would be obtained on a similar joint in compression. This is indicated in Fig. 1 by Rockwell readings taken before and after a tension test of a fish-mouth joint. In aircraft structures the members are welded to form a truss (Fig. 8) and the highest stresses on the principal joints will be compressive. The fish-mouth joint has higher strength under compression than the straight butt weld, since the softening due to the heat is not localized to the same extent.

An example of the difference between the strength in tension and compression is indicated in the table below, which represents the average of three tests on butt-welded joints. The compression test was made by testing the welded specimen as a short column with the base of the column at one edge of the welded seam. The column collapsed by local failure adjacent to

This article was prepared by Mr. Johnson as a contribution to the Report of the Oxy-Acetylene Committee of the International Acetylene Association for 1928. An abstract of it was included in the printed report presented at the Annual Convention of the Association held at Chicago, November, 1928. Illustrations by courtesy of Airway Age.

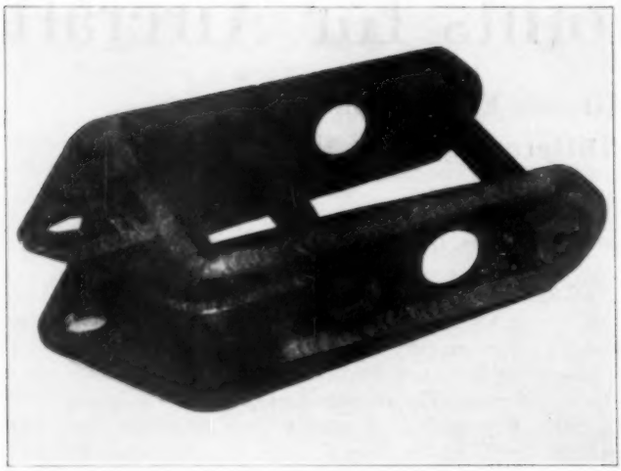


Fig. 3. A Well Balanced Design of a Welded Fitting. Breaking Load, 23,300 Lb.

the opposite edge of the welded seam about one-half inch from the point of support.

the corner of the lug fit into the corner made by the vertical and horizontal tube. Slotting the vertical tube and making the lugs from one piece increases the cost and is unnecessary. The lug may also be made of a thin piece of sheet metal bent flat on itself with the bend on the outside and the two legs flared out and welded to the tube.

Tubular members for tension wires 3, Fig. 2, are used occasionally, but necessitate the use of piano wire which has been practically superseded in this country by cold-rolled or cold-swaged tie rods and standard clevis ends.

The joint represented in 4, Fig. 2, will practically always develop the full tensile strength of all three members. If, however, the number of tubes joined into a cluster of this type are increased, some of the welds are apt to be defective because of the strains caused by the expansion and contraction of the several components on the application of the heat necessary in order properly to fuse the previously welded seams so as to fasten on another member. Fig. 10 represents a cluster of twelve tubes, two of which failed in tension during a sand load test.

It is seldom necessary to make a splice in a longitudinal member where the two parts are of the same diameter. Methods of

Fig. 4. Combined Tensile and Vibratory Tests on Carbon Steel Empennage Fittings.

The tension specimens were pulled in the usual way by gripping both ends of the specimen and pulling with the weld in the middle of the specimen. The tubes used in making the above tests were plain carbon seamless steel tubes containing .25 per cent carbon.

Size of tube, in.	1 in. dia., .035 in. wall
Ultimate compressive strength, lb. per sq. in.	48,690
Ultimate tensile stress, lb. per sq. in.	60,960

A butt weld can be considerably strengthened in both tension and compression by incorporating it in a T joint, and in this case the butt joint will have a strength comparable to the fish-mouth joint. This strengthening may be due to the vertical leg of the T or to lugs welded on as terminals for wire tension members, 1 to 4, in Fig. 2. All of the joints shown in Fig. 2 represent designs which have been used satisfactorily. In case the vertical strut is heavily loaded it is advisable to put a telescoping tube inside the horizontal member to reinforce the joint and prevent local collapse. This is especially important at points where landing gear struts or center section struts are attached.

The tension lugs indicated in 2, Fig. 2, will invariably either tear away the wall of the tube or shear at the pin hole, rather than break in the welded joint, provided the lug itself is properly designed to break the wire tension member. The length of the welded seam should not be decreased by undercutting the lug so that it makes an acute angle with the tube, as shown at dotted line *A*. When a thin sheet is used for the lug and the thickness of the lug is built up by means of a washer or similar device in order to give sufficient bearing for the clevis pins, it is advisable to increase the length of the welded seam, as shown in dotted line B, Fig. 2. This latter scheme sometimes obviates cracking at the edge of the lug. It is a neater design not to have

Methods of Splicing Tubes of Different Diameters

Table I—Values Taken from an Average of 50 Tests Represen tative of the Strength of a Butt Splice—Subhead twin slugs

It is generally assumed that a fitting built of solid sheet metal is stronger than one which has been reinforced by welding, especially when subjected to vibration. It is interesting to note the tests on two types of tension lugs (Fig. 4). Lug No. 1 was made of sheet metal .125 in. thick. Lug No. 2 was made of

Fig. 5. Service Failure of Lower Longeron at Landing Gear Attachment.

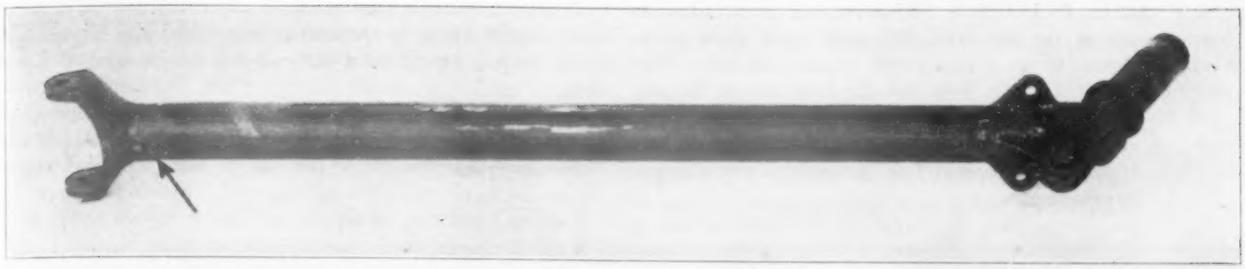


Fig. 6. Failure of an Axle Tube Due to Strains Set Up in a Riveted Joint.

splicing tubes of different diameter are shown in Fig. 2, and these methods will invariably give a joint of 100 per cent. efficiency for the smaller member. The telescoping members should project into the tube 1½ in. to 2 in. The parts so that it will pass through the tube as shown by the dotted lines in 9 and 10, Fig. 2. It is a good general rule not to use a welded seam in simple tension, but to distribute the load by supporting seams in shear.

Table I—Values Taken from an Average of 50 Tests Representative of the Strength of a Butt Splice

	CARBON STEEL C—.20 to .30			CHROME-MOLYBDENUM STEEL C. .25—.35; Cr, .80—1.10; Mo, .25		
	Tensile strength, lb. per sq. in.	Yield point, lb. per sq. in.	Elongation in 2 in., per cent	Tensile strength, lb. per sq. in.	Yield point, lb. per sq. in.	Elongation in 2 in., per cent
(a)	62,000	32,000	35	103,200	68,800	10
(b)	45,000	21,000	9	79,100	50,160	2
(c)	51,000	26,000	20	88,150	57,600	4
(a)	61,000	35,000	34	112,000	80,000	20
(b)	51,000	25,000	6	91,000	51,000	2.5
(c)	56,000	35,000	12	101,000	69,000	10

(a) Maximum
(b) Minimum
(c) Average (40 to 50 specimens)

Elongation represents actual limiting values and does not accompany the figures for tensile strength.

Table II—Tension and Compression Tests on Butt Welds—Average Values

Size of tube, in.	1 x 0.035 wall
Ultimate compressive strength, lb. per sq. in.	28,650
Ultimate tensile stress, lb. per sq. in.	60,960
Minimum letter width	3/5 of the height
Width of stroke	1/6 of the height
Minimum space between letters	¼ of the height
Approximate length of sign	Height of letter multiplied by number of letters

should be thoroughly fused together and a few beads of welding metal projecting on the inside of the tube is often a sign of good fusion. A welded seam which is simply stuck on the outer surface of a tube will not develop the full strength of the members in the joint. The results of tests on unreinforced joints in which one member telescopes over the other and the fillet seam is at right angles to the axis of the tube indicate lower strength than for a plain butt weld. The individual results are more erratic and in testing a welder's skill from the results on a tension test specimen, this type of weld is superior to the straight butt weld.

Tube and Sheet Metal Joints

The extensive welding of sheet metal parts to tubular members has been a more recent development. More failures have been experienced with the improper design of the combination of tube and sheet metal joint than of a joint in which all of its component parts were tubes or sheet. No. 9, Fig. 2, illustrates the method of making a butt weld of a lug directly to a tube. The welded seam should be of sufficient length so that the metal close to the weld will not be stressed beyond the ultimate strength of the material in the lug when in the annealed condition. For .25 per cent .carbon steel, this may be taken as 50,000 lbs. per square inch and for chrome-molybdenum steel as 80,000 lbs. per square inch. Using these values, the edge of the lug in contact with the tube will be of sufficient length so that the welded seam will have adequate strength, although made with a low carbon welding wire.

There are certain precautions, however, which should be followed. The line of pull (a) on the lug should not fall outside the edge of the lug so that a couple is produced which will tend to tear the end of the lug away from the tube. In case there is any bending load on the lug, such as would be experienced at a strut point due to flexure in the strut or due to the actual side load, the tube should be slotted and the lug should be prolonged

Table III—The Properties of the Principal Ferrous Materials Used for Welded Aircraft Parts

Physical Properties			
Tensile strength, lb. per sq. in.	Yield point lb. per sq. in.	Elongation in 2 in., per cent	Welded forms
40,000	24,000	35	Water jackets, exhaust stacks, miscellaneous, unstressed parts.
55,000	36,000	22	Fittings, lugs.
—Annealed—			Tail skids and miscellaneous parts to resist abrasion.
125,000x	100,000	10-over ¼	
		5-under ¼	Lugs, fittings.
125,000x	100,000	15-over ¼	Fittings, lugs.
		10-⅛ to ¼	Fittings, lugs.
		6-under ⅛	Structural parts; axles.
110,000x	80,000		Structural parts, axles. (often heat-treated)
55,000	36,000	22	
95,000	60,000	10	Structural parts, axles. (use limited)
125,000x	100,000	12	

x After heat treatment. Welding generally done before heat treatment.

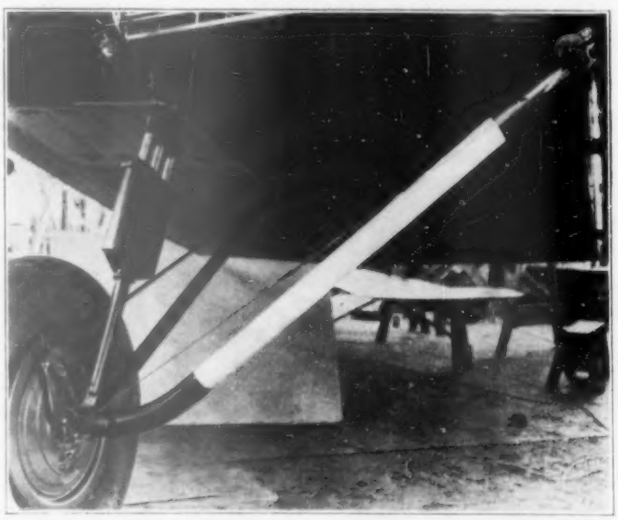


Fig. 7. Landing Gear with a Welded and Heat Treated Axle.

The application of the above principles can best be shown by a brief analysis of successful and unsuccessful designs. The use of a weld which combines shear and tension is illustrated in Fig. 3. This is a highly stressed wing fitting and is a good example of a weld design which combines light weight and rigidity without the sacrifice of strength.

sheet metal .087-in. thick with a washer welded on to increase the bearing area at the pin hole. The tests were made in a special jig attached to an Upton-Lewis fatigue machine. The lug was rigidly bolted at the base and the free end of the pin hole was vibrated while under a tensile load of 840 lbs. The amplitude of vibration and the number of cycles to failure are given. Both fittings broke through the pin hole, but the more flexible welded fitting, in spite of the fact that it was of thinner material, gave a longer life.

The concentration of stresses at the juncture of a light and heavy section must be carefully avoided in the design of a welded structure. The weld on the landing gear Fig. 5, was satisfactory, as indicated by the microscopic examination of sections cut through the weld. The metal in the lug was more than four times the thickness of the wall of the tube. The failure occurred through fatigue in the tubular member and was due to the design which permitted concentration of stresses at the juncture between a thin-walled tube and a heavy fitting. The failure of the axle tube Fig. 6, may be ascribed to the strains set up in welding a thin-walled tube to a heavy forging. The natural expansion and contraction was restrained by the rivets. Long tapered joints should be used to distribute the stresses over a larger area. The upper end of the axle tube Fig. 7 is a good example. An accurate stress analysis of a complicated welded fitting is sometimes impossible, and in such cases should be thoroughly tested before being incorporated in a structure.

The properties of the principal ferrous materials employed for welded parts of aircraft are given in Table III. Medium carbon steel is preferable to low carbon steel, in that it requires less cold-working in the final rolling or drawing operation to obtain the physical properties specified, and as a result a higher tensile strength is retained after the steel is subjected to the heat of the welding torch.

Chrome-molybdenum steel has air-hardening properties and the rapid cooling of thin sections in air promotes a strength and toughness at the welded joint which are lacking in the carbon steel. The use of chrome-molybdenum alloy steels in both the form of sheet and tube is increasing rapidly, due to this desirable characteristic. Several grades of welding wire containing less than .18 per cent. carbon, .60 per cent. manganese, .040 per cent. sulphur and phosphorus have been uniformly satisfactory. A carbon content of less than .10 per cent. is preferred by most welders. With thin material the thickness of the deposited metal is generally from 50 to 100 per cent. greater than the base metal and therefore the actual strength in the seam is sufficient without the use of alloy steel welding rod. Experiments with butt welds

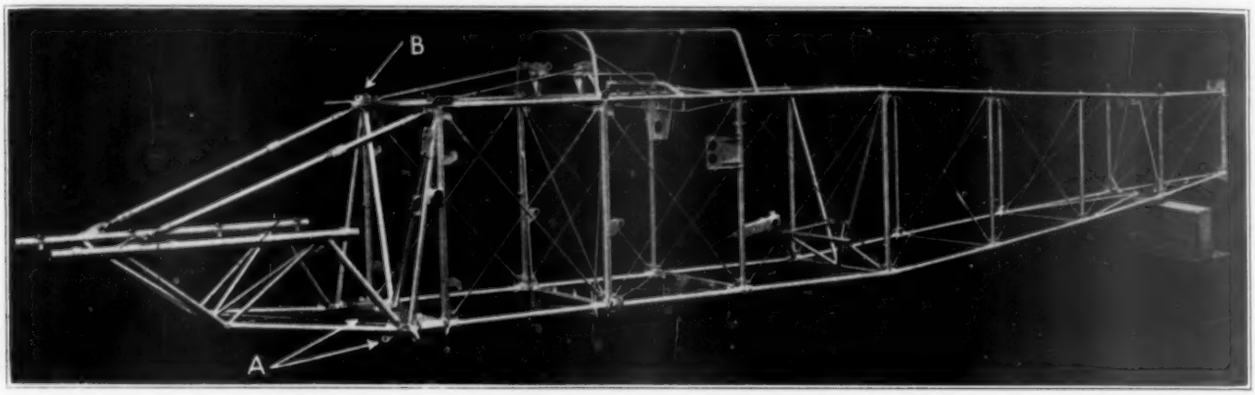


Fig. 8. A Typical Welded Structure—All Carbon Steel Tension Legs Welded to a Chrome-Molybdenum Steel Tubing

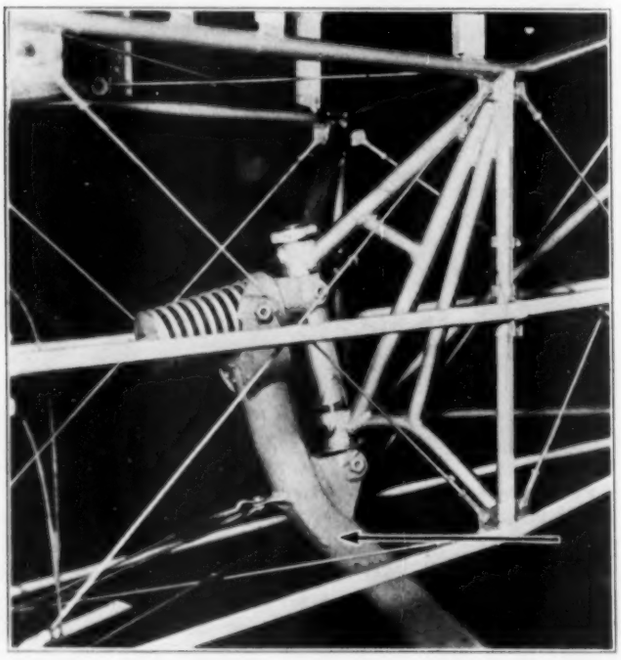


Fig. 9. A Heat Treated Tail Skid.

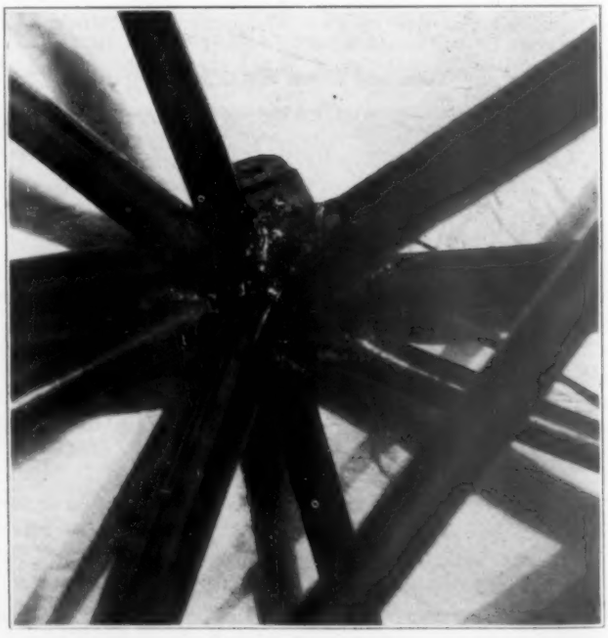


Fig. 10. A Tube Cluster Showing the Character of the Failure.

made with vanadium and chrome-molybdenum welding rods and tested in a rotating beam machine indicate no superiority in the fatigue resistance of the seams made with the alloy steel wire. All specimens broke in the middle of the seam formed by the deposited metal.

The fuselage and other large welded structures are not annealed or otherwise heat-treated at the joints. There is a pronounced change in metallographic structure between the deposited metal and the part adjacent to it. This probably represents an undesirable condition, but it is questionable whether it has a detrimental effect on the serviceability of the joint. The annealing of a tubular joint would tend to anneal the members at a distance from the weld, with a corresponding reduction in yield point, which would reduce the load-carrying capacity of the tube as a short column.

The heat treatment of welded parts by quenching and tempering in order to increase the tensile strength and thus permit the use of higher stresses is being done to a considerable extent. Sub-assemblies whose components are highly stressed members in the fuselage supporting the landing gear or engine bearers may be heat-treated and subsequently welded into the fuselage structure. The material in the joint immediately adjacent to the seam will be softened, but the other parts of the structure will retain the full strength obtained by heat treatment. Sub-assemblies similar in design to Sections A and B of the front section of the fuselage, Fig. 8, are heat-treated to develop a tensile strength of 125,000 lbs. per square inch before being attached to the structure. The axle shown in Fig. 7 represents a type of welded joint which can be satisfactorily quenched and drawn without cracking to develop a unit stress of 200,000 lbs. per square inch. The welded tail skid assembly Fig. 9 was heat-treated to develop a tensile strength of 180,000 lbs. per square inch.

PREHEATING IN CONNECTION WITH WELDING

By A. E. Swanson, St. Paul Welding & Mfg. Co.

In the old days of oxy-acetylene welding many a job was spoiled through not protecting against the evil known as contraction and expansion. Men, new in the art, were apt to attempt to weld all sorts of complicated castings only to find that after their labors were over the pieces either cracked or warped. It didn't take many of these jobs, though, to teach the welder that nearly any kind of a casting could be welded if proper precautions were taken to heat the part first. As a result the welding shops that had sprung up all over the country resorted to the easily-obtainable though treacherous charcoal as the preheating agency. The sickening gas given off from the charcoal caused many a headache and nauseated stomach, but charcoal simply had to be used till something better could be found. Then came along the kerosene torch.

Torit 8-K Preheater.

With the introduction of kerosene-burning torches which could be quickly put into operation, giving a sufficient flame to heat the largest castings, heating of steel as well as cast iron has been found a great aid to good welding. A cracked auto cylinder block, or a broken cast iron gear, or any iron casting can be successfully welded if first preheated. And if the preheating is properly done the casting will show no warp or strain after the weld is completed. The weld will also be "soft" so that it may easily be machined if this is necessary. Heavy wrought iron and steel parts should also be preheated to preserve their "soft" and machineable character.

Shops doing considerable welding can save a lot of expense and trouble by using the kerosene preheater. A heavy steel-welding job will consume an enormous amount of oxygen and acetylene if preheating is not resorted to, and besides this, the job will not be so dependable if welded cold. On the other hand the welder who uses the kerosene preheater may be busy with other work while the preheater is on the job. The time so saved will in a short while pay the entire cost of the preheating equipment.

Among the kerosene preheaters on the market there are two types from which a selection can be made. There is the portable type where the air is hand-pumped and there is the torch for use with an air compressor. The hand pump type must be used if no air compressor is to be had. It will operate steadily hour after hour with occasional pumping, and as it consumes only one or two gallons of kerosene per hour, the cost is very little.

Torit 9-K Preheater.

The kerosene preheater for use with air from a compressor gives a somewhat hotter flame than the hand-pump type. It also, of course, burns more kerosene per hour. Its particular advantage though, over the hand-pump type is that it produces a flame instantly, with the lighting of a match, while the head and coil of the hand-pump type must be heated before ready to operate. The air compressor type uses air direct from the air tank and the oil is siphoned from any convenient container, so this type is comparatively low in price, as only the torch and hose are necessary.

While these types of torches are designed especially for preheating in connection with welding they may be put to various other uses. Wherever a large, hot flame can be used kerosene torches will be found invaluable. They are handy for shrinking and expanding steel tires and shafts, for thawing frozen pipes and melting snow and ice. Boiler shops and foundries can use them to good advantage. Street railways and other public utilities have considerable use for the hand-pump type on outside work. Nearly every industry can find numerous uses for kerosene torches. Their range of usefulness is so great that even mushroom growers and silver fox farms resort to them for burning and destroying insects and bacteria.

PREST-O-LITE ACQUIRES ARIZONA AND TEXAS PLANTS

As of January 1st, 1929, The Prest-O-Lite Company, Inc., acquired the business of the Acetylene Products Company, which operated two acetylene producing plants located respectively at 401 E. Buchanan Street, Phoenix, Arizona, and at 914 Texas Street, El Paso, Texas.

These plants are now being operated as units of the Prest-O-Lite chain. Including these additions, the Prest-O-Lite plants now number 38, located at industrial centers throughout the country to supply the local demand for dissolved acetylene used in welding and cutting.

Mr. Everett R. Kirkland is superintendent of the Phoenix plant, and Mr. Carl F. Chosak is superintendent of the El Paso plant. Mr. R. G. Daggett, whose headquarters are at the San Francisco office, is district superintendent.

Welded Splice Stronger Than Girders

New Design of Splice Performs Double Function as Joint Equal in Strength to Girders, and as Stiffener for Web and Flanges

By A. W. Schenker, M. E.*

SPLICING OF GIRDERS

By A. W. Schenker, M. E.*

THE splicing of girders presents an interesting example of the economies that can be effected by the application of welding. Splicing is a necessary evil. Both mill and transportation requirements restrict the lengths of sections making splicing essential.

The design of the riveted splice has been thoroughly standardized and embraces theoretical and empirical considerations which have become conventional.

The welded splice of the type which has been furnished by the Electric Welding Company of America, in the past has been designed with a view of simulating the riveted splice. In other words, the welded splice consists of top and bottom flange plates and a pair of web plates. This set of plates is designed to develop the section modulus of the original section and the lengths of the plates determine the amount of welding required to develop the plates.

That this arrangement has decided advantages over the conventional method of splicing is proven by the fact that many thousands of these joints are in use and in at least one field has virtually completely superseded the conventional splice.

Yet a careful study of this type of welded splice will reveal that it is very greatly over-designed and that it is therefore not economical, or to put it more correctly, this splice is not economical enough.

Let us remember that welding differs fundamentally from other methods of joining metals in that an effort is made to make the joined metals literally integral. So that the ideal weld may be expressed as a partition of metal having all the properties of the parent or joined metals. Suppose then this ideal were attainable. The conventional or the aforementioned welded splice no longer becomes necessary.

The butt joint suggests itself as the nearest approach to this ideal. This however presents two major objections:

1. Lack of ductility.
2. Impossibility of developing full strength economically.

If two I-beams are butt welded together end to end and then subjected to transverse bending, it will be observed that the deflections are much larger for successive increments of loading than for a plain unspliced beam of the same dimensions similarly loaded. Furthermore, the elastic limit is reached very quickly. To offset this it is necessary to build up such a large volume of welding material at the joint that its cost becomes too great to be attractive.

The author has recently developed a splice which seemingly meets the foregoing objections. The splice consists of a plate placed between the ends of the beam to be spliced and a fillet weld is deposited for the full perimeter of the section on both sides of the plate. The size of the fillets below the neutral axis is designed to take the tensile stresses set up in the flange while the fillets above the neutral axis can be made lighter. It is interesting to note that the partition plate incidentally acts as a stiffener for the web and flanges.

Some preliminary tests have been carried on at the plant of The Electric Welding Company of America in Brooklyn, and also at the Brooklyn Polytechnic Institute and at Columbia University. The tests made at Columbia University were designed to subject the splice to direct flexure as well as flexure and shear. The report of these tests is given herewith. The accompanying photograph is a close-up of the welded splice after the specimen was removed from the machine.

New Design of Welded Splice, After Specimen Was Tested. Failure Occurred in the Beam.

REPORT OF TRANSVERSE BENDING TESTS MADE UPON WELDED AND CONTINUOUS I-BEAMS

Submitted by

The Electric Welding Company of America
Foot of Court Street, Brooklyn, N. Y.

Report No. 2015 November 26, 1928.

General:

The material subjected to test consisted of four (4) standand 5"—10# I-beams. The specimens were submitted by the Electric Welding Company of America, Brooklyn, N. Y., and tested as described in accordance with your letter of November 23rd, 1928, signed by Mr. A. W. Schenker.

Description of Specimens:

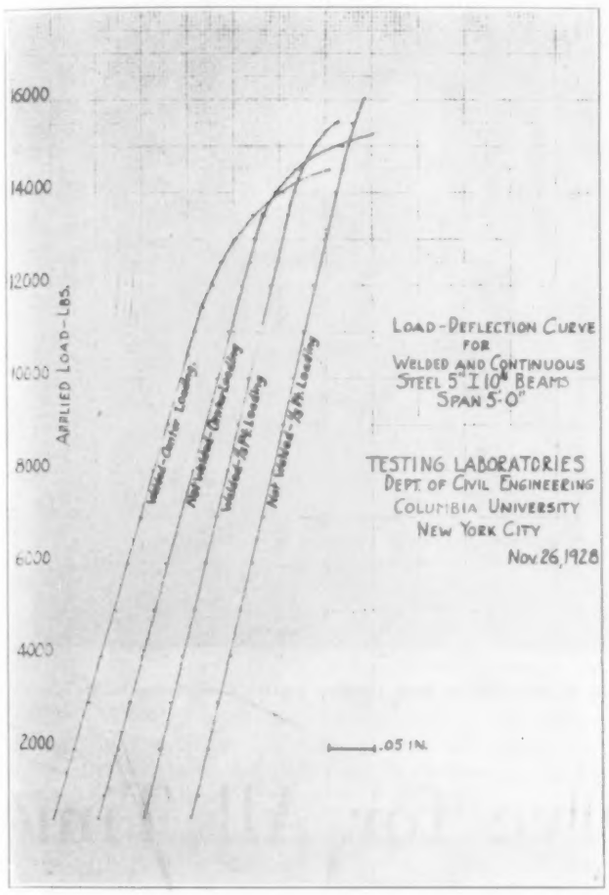
The I-beams tested in transverse bending consisted of six foot lengths of 5"—10# standard beams. Two of the specimens were continuous while the other two were made up of two 3 foot lengths butted and welded to a 4"x6"x⅜" plate. The method of connection consisted in butting one end of each I-beam to the plate and welding along the edges of contact. The welding formed triangular fillets between the I-beam surfaces at the ends and the separating plate. These fillets extended about ⅞ inch from the contact.

Method of Test

Each I-beam tested was placed in a 400,000 lb. Olsen Testing Machine and simply supported on rocker bearings with a span of five feet. One pair of beams, namely, continuous and welded at mid-span, were subjected to load at mid-span. Because of the form of the weld connection, this load was transmitted through two 1"x1" bars laid across the upper flange 1½ inches apart so as to straddle the weld. For purposes of comparison the continuous, unwelded beam was-

Chief Engineer, The Electric Welding Co. of America.

loaded in the same manner. The other pair of beams were each subjected to transverse load applied at the third point of the span; i. e., 10 inches from the weld. This procedure was intended to subject the welded section to shear as well as flexural direct stress.



Graph of Results of Deflection Test of Welded and Continuous I-Beams.

In either method of test the load was applied at a slow and continuous rate, and center deflections were recorded at 500 lb. increments until the "yield point" was definitely exceeded. Maximum load was determined with a slightly increased rate of motion of the cross head of the testing machine.

Witnesses:

These tests were witnessed by the following:

Name	Representing
H. F. Hughes, President	Electric Welding Co. of America
A. W. Schenker, Chief Eng'r	Electric Welding Co. of America
G. H. Boyd, Manager of Distribution	Consolidated Gas Co. of N. Y.
J. L. Miller, Engineer of Bridges	N. Y. Central Railroad Co.
F. J. Pitcher, Ast. Eng'r of Bridges	N. Y., N. H. & H. Railroad
H. A. Dice, Engineer	Erie Railroad
E. Taylor, Engineer	Erie Railroad
J. B. Smiley, Engineer	McClintic Marshall Co.
N. Stadtfeld, Asst. Eng'r	Board of Transportation
G. Theissinger, Engineer	Board of Transportation
O. O. Robinson, Engineer	Department of Plant and Structures
S. Weinberg, Engineer	Department of Plant and Structures

Results of Tests:

The following tables give the results obtained in testing the I-beams described:

TABLE I

TRANSVERSE BENDING TEST

Test No.	44687	44688	44689	44690
Specimen	Welded	Not Welded	Welded	Not Welded
Load Applied	(At Center)		(At one third point)	
Maximum Load lbs.	19900	19100	21250	21900
Failure	No failures were produced in the welds. Flexure followed by buckling of upper flange.			

TABLE II

DEFLECTIONS UNDER APPLIED LOAD

Test No.	44687	44688	44689	44690
Specimen	Welded	Not Welded	Welded	Not Welded
Load Applied	(At Center)		(At one third point)	
Load in lbs.	Deflections at Mid-span, ins.			
500#	0.000"	0.000"	0.000"	0.000"
1000	.007	.005	.006	.008
1500	.015	.015	.011	.013
2000	.023	.023	.016	.020
2500	.032	.029	.022	.026
3000	.041	.034	.028	.030
3500	.048	.041	.036	.038
4000	.055	.048	.042	.043
4500	.062	.055	.049	.050
5000	.071	.062	.056	.056
5500	.077	.069	.062	.063
6000	.085	.075	.068	.069
6500	.092	.083	.074	.075
7000	.099	.091	.081	.081
7500	.105	.097	.087	.088
8000	.112	.104	.092	.092
8500	.121	.115	.098	.097
9000	.128	.121	.103	.103
9500	.137	.127	.110	.107
10000	.144	.131	.115	.115
10500	.151	.136	.121	.120
11000	.158	.143	.126	.126
11500	.168	.150	.132	.131
12000	.177	.158	.138	.136
12500	.186	.164	.146	.142
13000	.201	.173	.152	.148
13500	.221	.182	.160	.154
14000	.253	.196	.166	.160
14500	.303	.218	.174	.168
14900	.393	——	——	——
15000	——	.268	.189	.174
15250	——	.301	——	——
15500	——	——	.212	.179
16000	——	——	——	.191

These load deflection data are shown graphically by the attached curves.

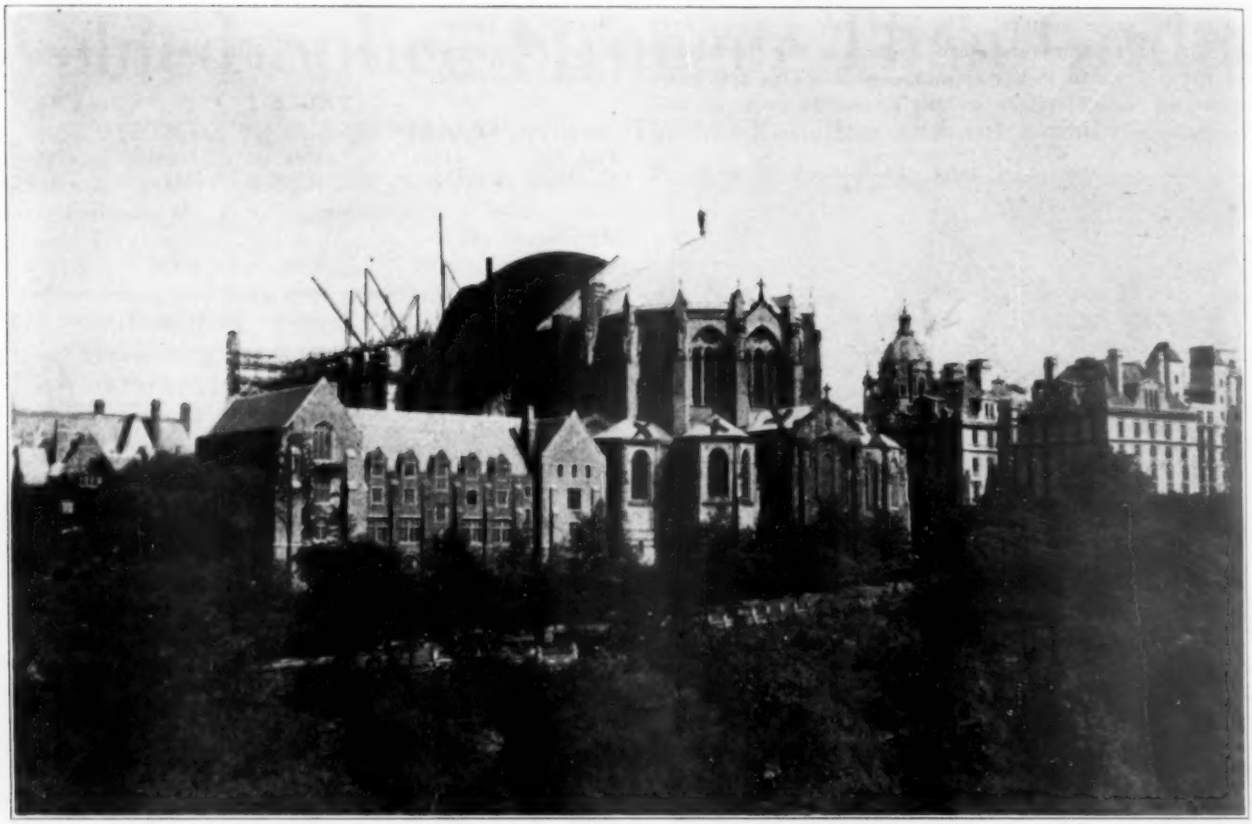
Respectfully submitted,

Testing Laboratories,
Per W. J. Krefeld,
Engineer of Tests.

The results of the tests thus far appear to corroborate the theory upon which the design of this splice is based.

Preparations are now being made to carry on more extensive tests on larger beams and some consideration will be given to impact and fatigue.

Meanwhile, the practical advantages and the economies effected are so obvious that it is hoped it will contribute in a measure toward arousing the ultra-conservative engineer to the many other advantages which this fascinating subject of welding offers to the practicing engineer.



Rear View of the Cathedral of St. John the Divine, Which Is Requiring a Half Century for Its Completion.

Welding Pipe to Serve for All Time

Cathedral Built to Stand for Unnumbered Centuries Includes Welded Piping Throughout, Buried in Twenty Feet of Masonry

ALREADY thirty-eight years in the building, and many more years required for its completion, the Cathedral of St. John the Divine, in New York City, is being built to withstand every storm that blows for unknown centuries to come. A magnificent work of ecclesiastical architecture and modern engineering, 600 ft. long and 300 ft. wide, costing, completed, over $20,000,000, this great house of worship is surpassed in size only by St. Peter's at Rome and Seville Cathedral in Spain, and will no doubt endure long after either of these.

The Cathedral is not of steel construction, but of heavy masonry. The foundation is of Maine granite, going down in some places 72 feet to solid rock. Every detail is designed for permanence.

As part of the plan to make this structure as everlasting as man can make it, the entire system of steam piping, from the foundation to the roof, 135 feet above the ground, is being welded. The welding is being done by the Sound Welding Company, of New York City, under the supervision of Mr. A. F. Keogh of that company, and to whom we are indebted for the accompanying photographs. That the utmost confidence was placed in the welded joint by the architects is evidenced by the fact that these pipes, after welding and coating heavily with asphaltum and asbestos, are imbedded in the center of from eight to fourteen feet of solid masonry, where it is impossible to get at the lines to repair a leak.

Welded Piping Is Buried in These 20-ft. Walls of Masonry and Concrete, Inaccessible for Repairs.

The pipe used is extra heavy, varying from 1½-inch with a ½-inch wall to 4-inch with a 1-inch wall. The lengths are beveled at the mill, allowing a 45-degree angle for welding. The weld is built up to the thickness of the pipe and then metal is added for reinforcement. All bends are made in the field.

keep from freezing, the downspouts carrying the water from the roofs. In the gutters are perforated pipes which emit the steam to melt the snow and ice from the roofs. At the top of the copper pipe is a heavy brass strainer, inside of which is another perforated steam pipe to keep the strainer

1½-in. to 4-in. Used in Heating System. Note Thickness of Wall of All Sizes.

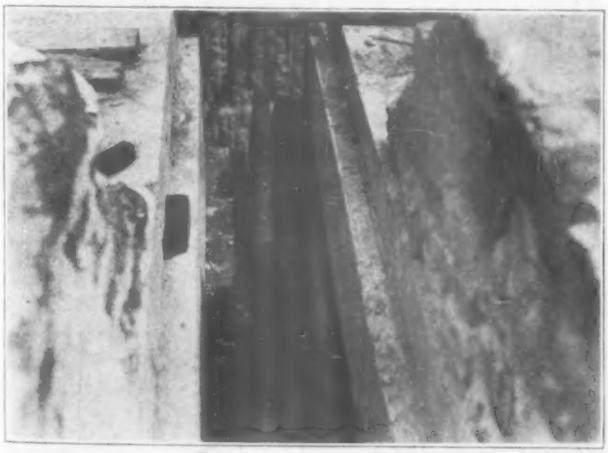
All Pipe Bends Were Made in the Field.

In each of the north and south walls of the nave are eight sets of pipe, consisting of eight 3-inch steam pipe and eight 1½-inch returns, anchored to the walls with heavy hangers. These pipes serve the radiators, located out of sight 63 feet above the floor of the nave. Another set of eight 2½-inch steam pipes run up through the walls, branching off at the 47-foot, 98-foot and 135-foot levels. The function of these pipes is to melt the snow from the roofs. Each set runs parallel to an 8-inch copper downspout, which they

and pipe free from ice.

In the west front are seventeen groups of pipe: three 4-inch and three 3½-inch steam mains; fourteen 2½-inch snow risers; four 1¼-inch for returns; a total of twenty-seven risers, buried for all time behind tons of stone.

The contractor in charge of the pipe installation predicts that it will not be long before the majority of architects will specify welded joints with the same confidence as has been displayed by the architects of this great cathedral.



One of Several Series of Pipes Laid in the Foundations and Walls.

Welder Completing a Section in the Foundation, 82 Ft. Deep.

A TECHNIQUE WHICH SAVES GAS

In a recent contribution to the Zeitschrift fur Schweisstechnik, Professor C. F. Keel comments on numerous tests made to show the advantage of welding in an inclined direction. The torch is held so that the flame precedes the filler rod and advances almost perpendicularly along the seam. The filler rod thus follows the flame. This method of manipulation is indicated to have two principal advantages over horizontal welding. First, it permits using a torch of a smaller capacity for the seam thickness without reduction of speed, thus obtaining a saving of acetylene and oxygen; second, the quality of the weld is said to be better. The tests referred to by Professor Keel showed a saving of 25% in gas consumption. Another advantage gained was the use of a filler rod of somewhat smaller diameter. If the filler rod is too thick the metal flows too much, especially when the line of weld is nearly perpendicular; whereas the smaller filler rod is a help in getting better penetration in the weld. One reason given for the advantages gained for this procedure is that the hot flame rises against the parent metal instead of rising into the open air with no effect, as in the case of horizontal welding. Professor Keel makes particular mention of the fact that this method of procedure is very easy to learn.

LARGEST COPPER STILL EVER MADE IN AMERICA BRAZED WITH SILVER SOLDER

The problem of welding the seams of copper industrial alcohol stills with a material that would withstand the attacks of butyl acetate or other corrosive agents was solved with silver solder by the Ansonia Copper and Iron Works at Cincinnati, Ohio.

The cylinder illustrated is believed by its makers to be the largest copper tank ever constructed in America. It was built for the United States Industrial Alcohol Company, of Peoria, Illinois.

Nine 133x195¼ in. rolled sheets of ¼-in. Anaconda Copper weighing 18,300 lbs. and two 133 in. quarter-inch rolled

Large Copper Still Brazed with Silver Solder.

copper circles weighing 2,700 lbs. were used in its construction. The completed cylinder with its coils weighed 14 tons.

There is not a rivet in it. All seams were brazed with silver solder, by means of oxy-acetylene torches.

After completion the tank was tested under 5 lbs. hydrostatic pressure, and the coils at 200 lbs. No leaks developed. Sample sections of seams on body were sent to Johns Hopkins University, where they withstood pulling tests equivalent to 29,000 lbs. per sq. in. Failure was shown in the body of the metal back of the seam, not in the seam. In other words, the silver-welded joints were stronger than the metal they joined.

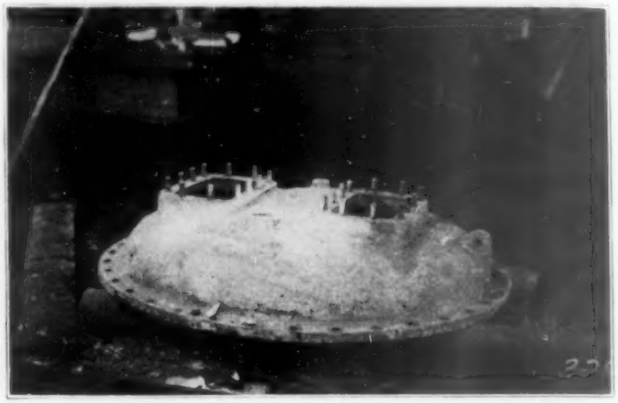
However, as already indicated, silver solder was used because of its resistance to corrosion, in addition to its strength. It took the place of the bronze formerly employed by this company on alcohol still work, because this bronze was attacked by the acids used in the distillation process. The silver solder was furnished by Handy and Harman, New York City.

AN INTERESTING BRONZE-WELDING APPLICATION

An interesting application of the oxy-acetylene process which was recently completed at the plant of a starch refining company convinced the superintendent of that establishment of the value of a welder and oxy-acetylene welding equipment.

The head of a condenser used in the refining process suffered an 18-in. break and it looked very much as if a serious loss would result. This condenser head was an intricate casting and would have been very costly to replace. The plant welder was called in and after looking over the piece and examining the nature of the break, decided that it would be best to preheat and bronze-weld.

Under ordinary conditions preheating operations are not necessary in bronze welding. Owing to the size and design of this job, however, the extra precaution was taken. Consequently a furnace of loose firebrick was built up. The condenser head was placed in the center of this temporary preheater, the base of the piece resting on two six inch pipes. The next steps were to clean the crack thoroughly with a stiff wire brush and prepare and light a charcoal fire under the casting. An asbestos paper covering was placed over the job and the entire casting was allowed to come to an



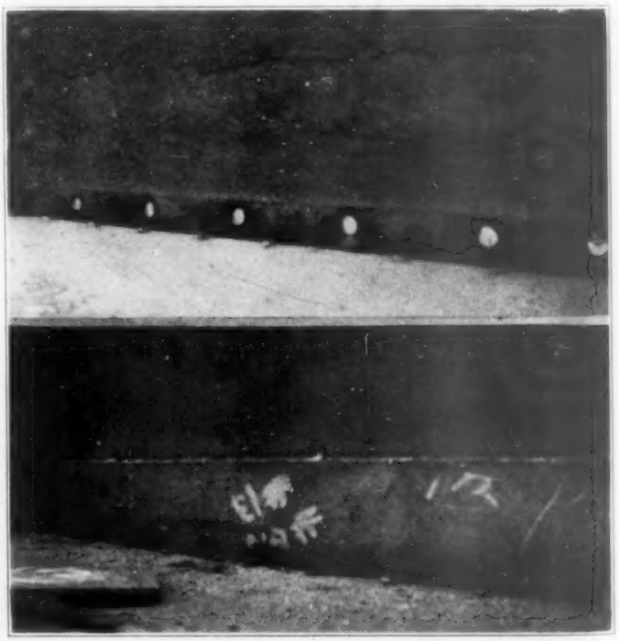
Condenser Head Bronze-Welded Successfully.

even temperature. Bronze welding was then begun. A standard high grade bronze rod was chosen and a good quality of flux used to float off impurities.

After the weld had been completed the casting was allowed to remain in the furnace in a dying fire so that cooling would be gradual and uniform. The repair was a complete success and a lasting testimonial to the value of the process.

WELDING SIMPLIFIES REPAIR OF BRIDGES

An interesting welding repair job is being done in the reinforcing and strengthening of twelve railroad viaducts and bridges extending over the streets of Chicago. The work is



Above Girder Stripped for Repairs.
Below—Reinforcing Plate Welded In.

being carried on by means of the electric arc process with current supplied from two portable gas-engine driven generators, both mounted on light auto trucks. On the particular job visited, the old bottom plates had been ripped off and, as one may see in the upper half of the illustration, the rivet holes and the adjacent metal of the beam had become dangerously rusted. The procedure in the reinforcing of this particular place was quite simple. Measurements were taken, a plate was layed out and marked, and a cutting torch reduced

to the proper dimensions. Then it was fitted into position and tack welded to hold it and prevent shifting from expansion and contraction. After that the beads was layed in lengths of about a foot and a half or two feet along the seam, the welder shifting from one place to another to maintain the correct alignment of the plate. The neat appearing, permanent job shown in the lower photo was the result of this work. Undoubtedly this addition to the structure will be with it as long as it lasts. The bridges being welded are the property of The Chicago & Northwestern Railroad and the work is being done by The Anchor Welding Service Co., Chicago, Illinois. Mr. G. W. Hettrick, president and general manager of the company, is supervising the work and as yet has not encountered any trouble in connection with it.

ARC WELDED PILE DRIVER

Electrically arc welded pile driver illustrated here is one of four made by the Mississippi Valley Structural Steel Company of Melrose Park, Ill., for the Walsh & Masterson Company of Chicago. These machines are subject to very heavy duty, in-

Arc Welded Pile Driver Stands Up Under Rigorous Service.

volving terrific vibration, night and day. After nine months of service they show as rigid as when first built.

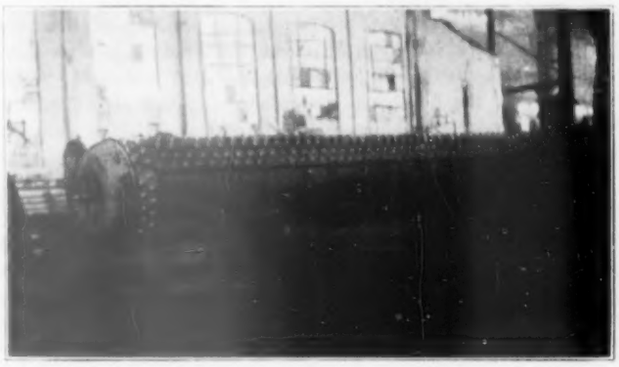
Each pile driver is 81 feet high and operates a steam hammer weighing 10,300 pounds. At no sacrifice of strength, a 15 per cent saving in material was effected in the construction of each. One of the principal advantages of the lighter weight thus secured is the greater ease with which the machines can be moved from place to place.

With the exception of two guides for the hammer, made of special Carnegie beams, the material used is standard angles. A General Electric arc welding set was used in the fabrication.

WELDS IN BOILER PLATE STAND SEVERE ABUSE.

An excellent example of what a well-made weld will stand was recently observed at a large plant in Canada. Two-inch plate was rolled to form a boiler drum 36 inches in diameter and 26 feet long. The seam was tacked by a 9-inch weld at each end, and the drum jacked up and the ends machined for the heads. The butt straps were then put on with 1¼-inch rivets driven by a hydraulic riveter, one hole going directly through the center of each weld.

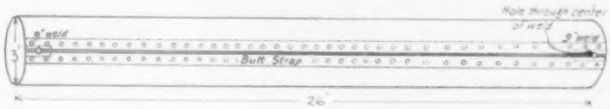
After the heads had been shrunk on and riveted, a flaw was



Boiler—Showing Butt Strap Placed Over Welds.

found in the straps, which were condemned and taken off. The heads were reheated and forced off, one head requiring two heats. The welds were still good. The entire job was riveted once more and given a rigid test, and the welds still held.

The welding procedure was as follows. The ends of the plate were double-veed to the length of the welds, and after



Drawing—Shows Location of Welds. Note Rivet Through Center of

laying down two layers the welds were gone over with the roughing tool, and this procedure of alternate welding and roughing continued until the welds were complete. As the temperature in the shop was at the freezing point, two 2½-inch plates, 8 inches square, were heated and applied to the plate for annealing, when the weld was partly finished and when completed.

OXY-ACETYLENE IN THE STRUCTURAL FIELD

In the fabrication of structural steel, welding has advanced well beyond expectations. From the start, the advocates of structural welding, which not alone includes the welding of structural building steel, but rolled steel products for structures of all classes, have aimed high and the activities in this field of welding, in jobs accomplished and in immediate contemplation stand to attest to the soundness of their judgments.

While many of the details of the earlier determinations in structural welding design have been improved upon or modified by the more recent experiences, none of these applications have developed structural deficiencies. To date, with nearly a hundred major applications, there is yet to be reported a failure.

The significance that can be ascribed to this record is none other than that sound welding intelligence guided this entire development. The welding industry has learned that each case of welding requires a specific procedure control and when such is followed, the results are invariably satisfactory. This knowledge was available when the welding of structural steel was embraced, however, extensive supplementary experimental tests were conducted to verify the then existing data before any major commercial structures were weld fabricated. Many of these experimental tests were in full size scale and included columns and beam connections, built up girders and roof trusses.

**Reprinted from the Report of the Oxy-Acetylene Committee of the International Acetylene Association.*

These preliminary tests results provided the ground work of proof of feasibility for structural welding, which, coupled with the results of applied cases, are responsible for the present wide interest and scope of this welding application.

Hand in hand with the development of welding of structural steel framing for buildings has been the gradual conversion of iron and steel castings to welded rolled steel materials. While the details of the latter are somewhat more difficult of solution than those for steel framing, their solution has provided additional design data for the structural welding engineer.

Concurrent with each important step gained, the welding industry has clearly published the essential points. Many of these accounts go into the most minute explanatory details as to design and construction procedures employed. As a result there are few fabricating and erecting organizations unfamiliar with the progress which has been made in the structural welding field. Many of them have well equipped welding departments and with representation on welding committees. The engineering colleges have turned their attention to this field of welding and many of them have made valuable contributions in the way of data on the strength of welded joints and specimens. The Structural Division of the Bureau of Standards has contributed a very avluable service in this respect, having provided the facilities for the testing of welded specimens of dimensions exceeding the capacity of the average testing laboratory.

During the past year there has been a marked interest shown in structural welding on the part of Municipal Building Departments. Several of our larger cities are, through their Building Code Committees or Advisory Boards, undertaking to revise their Building Codes to permit the welding of structural steel thereunder. A number have solicited information for study, contemplating code revision.

An important factor in the fabrication of structural steel, especially so by welding, is the shaping of the parts or members for assembly by oxy-acetylene cutting. The real value of the cutting torch operation is being better appreciated by the fabricators and its use is fast being extended to all departments of the fabricating and erection industry. The application of oxy-acetylene cutting in this industry is not one of rough severing as in demolition work. It must sever the metal accurately to the dimensions prescribed, especially so at junction points in the shapes.

OREGON AGRICULTURAL COLLEGE HOLDS WELDING CONFERENCE

The first of a series of welding conferences on the Pacific Coast was held at the School of Engineering of Oregon State Agricultural College, Corvallis, Oregon, February 7th to 9th. This conference was held under the auspices of the department of Industrial Arts, in the engineering shops of the college in co-operation with the Department of Mechanics and Materials and manufacturers of welding and cutting equipment. The purpose of the conference was to bring together on the campus a group of specialists in the fields of electric and acetylene welding and to extend the services of the college to all who may be interested in the latest development and possibilities of welding. The lectures, discussions and demonstrations were naturally of primary interest to engineers, architects, designers, manufacturers, contractors, mill-men, plumbers, steam-fitters and welding operators. The program was planned so it would be of particular value in these fields of work and to introduce the latest welding methods and the technical considerations necessary to the fullest efficiency of those methods. Some of the papers pointed specifically to the increasing importance of welding as a means of improving the product and of increasing the speed of production. Formal papers were presented covering the following subjects:

Forces acting on structural joints.

Electric Arc welding of structural details.

Contributions of gas welding to modern production.

Electric welding of steel bridges.

A brief review of the structure and properties of industrial metals, normal and treated.

The flow of welding metal in both metallic arc and gas welding.

The alteration in normal structure and properties of metal caused by welding.

Influences of modern welding processes upon machine design and production.

Oxy-acetylene welding of steel.

Atomic hydrogen arc welding.

The electric arc as a factor in machine design and modern manufacture.

The modern spirit of industry.

Gas and electric welding in the automotive repair service.

Some welding problems in railroad repair work.

This program was supplemented by demonstrations of all of the welding processes and open discussion on the subjects of the lectures. A bit of entertainment was provided during the program in the form of orchestra numbers furnished through the courtesy of the Department of Music and some athletic exhibitions furnished through the courtesy of the Department of Physical Education. On the evening of second day those who were attending the conference got together for an informal dinner at the Memorial Union Building.

CURRAN APPOINTED METALLURGICAL ENGINEER

James J. Curran, for many years metallurgist with the Southern Engineering Co., Hartford, Conn., is now metallurgical

James J. Curran.

engineer with the Harrisburg Pipe and Pipe Bending Co., Harrisburg, Pa.

Mr. Curran, a native of New Britain, Conn., was educated at Worcester Polytechnic Institute and Cornell University. During the war he was employed as chemist and metallurgical inspector of war materials. Since the war he has been engaged in general metallurgical investigation and consultation with the Henry Souther Company.

In his new connection Mr. Curran will be in charge of

chemical and metallurgical control and development of the varied line of carbon and alloy steels, hydraulic and drop forgings and drawn seamless cylinder specialties manufactured by the Harrisburg company.

Mr. Curran is a member of the American Society for Steel Treating, the American Foundrymen's Association and the Iron and Steel Institute (British).

HOW TO BRONZE WELD CYLINDER BLOCKS

"How to Bronze Weld Cylinder Blocks" is the title of a booklet recently issued by the Linde Air Products Company, New York City. This is a twelve page illustrated booklet of convenient size which explains in detail the preparation for bronze welding, the welding of a cylinder block in place, chipping, welding equipment to use, heat control, location of cracks, the welding operation, and the methods of finishing. Considerable attention is given to explaining different precautions which have to be taken to make sure of a satisfactory job and the materials and equipment which are well to have on hand in order to do the work with the least possible delay and expense. If some of the operations involved in the same repair can be done by more than one method, details of various methods are given in the booklet. It is thus made useful to shops having a wide variety of equipment. Although prepared especially for the benefit of those who wish to use bronze in the welding of cylinder blocks the information given in the booklet is so complete in detail as to make it a valuable piece of literature for all shops who use bronze for repair work.

SMITH ANNOUNCES NEW LIGHT TORCH

The Smith Welding Equipment Corp. of Minneapolis, Minn., has recently announced a new light weight torch particularly designed for welding of light metal parts such as airplane fuselages and sheet aluminum. This is designated as Smith's No. 2 Welding Torch, and is described in a leaflet which they are sending out to those interested.

ISSUE SET OF INSTRUCTIONS ON WELDING ENDURO

A leaflet has been prepared by the Central Alloy Steel Corp., Massillon, Ohio, which gives instructions for welding their Euduro Stainless Irons by the electric arc and oxy-acetylene processes. Size of rod, and voltage and amperage to use for various thicknesses, are given, as well as the proper procedure to follow in welding, and treatment of the various analyses after welding. This leaflet can be obtained from the Central Alloy Steel Corp., or from Maurath, Inc., 1371 E. 18th St., Cleveland, Ohio.

NEW COMPANY TO MAKE RESISTANCE WELDERS

The General Welder Company, 95 Steiner Ave., Akron, Ohio, was recently incorporated for the engineering and manufacture of special welding machines for mass production. Mr. B. T. Mottinger, formerly connected with the Federal Machine & Welder Company, Warren, Ohio, as Special Engineer, has severed his connection with that company and accepted the position as President and General Manager of the General Welder Company. He has associated with him as Director of Engineering & Research, Mr. P. C. Zarrs, formerly connected with the Taylor-Winfield Company, Warren, Ohio, as welding Research Engineer. Mr. Zarrs has received letters in both Electrical and Mechanical Engineering at Berlin and Munich, Germany. For several years prior to coming to this country he was Director of Engineering for the Deutsche Schweissmachienen Fabrik, Dusseldorf, Germany. The new company contemplates the production of spot, butt, seam, and flash welders and will operate a machine shop, pattern works, bronze, copper and gray iron foundry in connection.

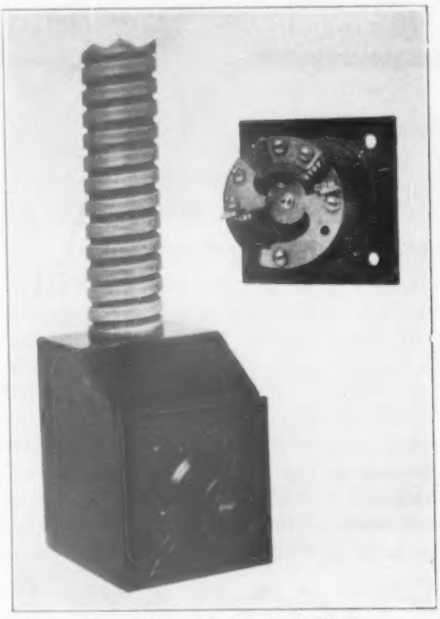
SALES CORRESPONDENCE FOR WELDING SHOPS

"Sales Correspondence for Welding Shops, by Larry Sherman, is the title of a new book just published by Larry Sherman & Co., Central Parkway & Elder St., Cincinnati, Ohio. During the past few years the author had a great deal of experience in preparing direct mail advertising for prospective customers. He has used seasonable sales letter advertising to garages in winter, also letters to general contractors relative to their particular needs, and to manufacturers relative to the general run of repair welding. He has collected from his files a list of sales letters which have proven very successful, together with letters acknowledging orders, letters prepared for the purpose of obtaining the good will of customers, and also a collection of letters used to speed up payments of past due accounts. This material has been consolidated into book form printed in the actual size of the letters which were used. The book sells for three dollars per copy.

LINCOLN DEVELOPS A SAFETY PUSH BUTTON

A new safety type push button recently developed by the Lincoln Research Laboratories is now being marketed by The Lincoln Electric Company, Cleveland, Ohio, manufacturers of "Linc-Weld" motors and "Stable-Arc" welders.

The design of this new safety push button is a departure from the usual design in that it offers unusual safety features. A ball top "start" button is contained inside a large "stop" button which projects over the "start" button. Thus the large projecting "stop" button protects the "start" button from accidental contact. The "start" button can only be operated by the tip of a thumb or finger inserted inside the "stop" button. The "stop" button can be operated by a finger or palm of the hand. The colors of push buttons are in accordance with the accepted standard signal colors for controlling railroad, vehicular and pedestrian traffic. The "start" button is of vivid green moulded Bakelite with the word START in white letters across the ball top face of the button. The surrounding "stop" button is of brilliant red moulded Bakelite. The inner mechanism is enclosed in an arc welded steel box 2½"x3¼"x2½" in size. All insulating parts are of moulded Bakelite. The entire exterior of the Lincoln safety push button is jet black with the exception of the push buttons.



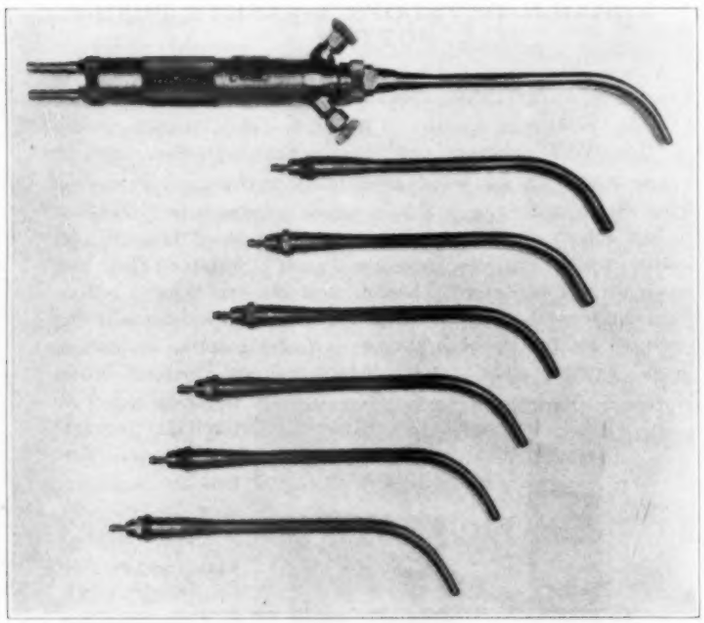
New Safety Electric Push Button.

Another distinguishing feature of the new safety type push button is the ease of installation. Four screws hold the moulded black Bakelite face plate to the container. By removing these screws the entire operating mechanism may be removed from the case for wiring. As can be seen in the illustration the binding posts are plainly indicated by white letters on the moulded black Bakelite, thus preventing chance of error in making connections. In top of the steel case an opening ⅞" in diameter permits entrance of conduit enclosed wire to the button. For easy atachment there are two holes in the back of the case for bolts, rivets or screws.

This safety type push button was designed primarily for use with the Lincoln Induction Starter but is available and suitable for use with any type of push button starter.

OXWELD PRODUCES AIRCRAFT BLOWPIPE

The Oxweld Type W-15 Aircraft Welding Blowpipe has been placed on the market by the Oxweld Acetylene Company, 30 East 42nd Street, New York City. This equipment fills the need for a blowpipe designed especially for aircraft fuselage welding. Like other Oxweld blowpipes it is of the injector type and can be used on a low pressure acetylene supply.



Seven Heads Supplied with New Aircraft Welding Torch.

Welding heads, supplied with the blowpipe, seven in number, are equipped with drawn copper tips to withstand high temperatures, curved to reach with ease the most inaccessible places encountered in aircraft welding. Each welding head is detachable as a unit and each injector can also be detached from the welding head and replaced if necessary. The welding head is connected to the body of the blowpipe with a double conical seat and is held in place with a knurled head nut. This nut is designed to be tightened by hand, but is also provided with faces so that a wrench can be used for loosening it if neecssary.

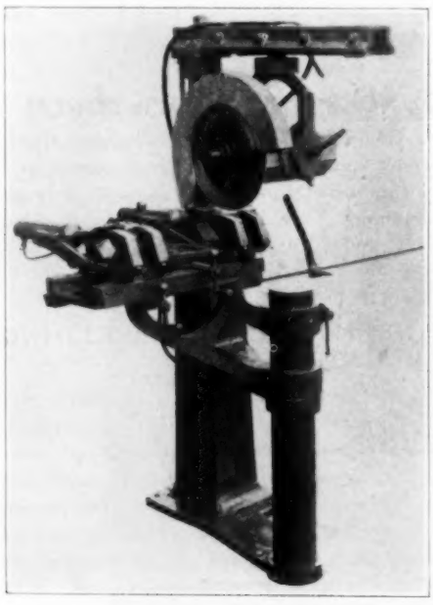
The type W-15 Blowpipe is of sturdy construction. The handled is knurled to provide a good grip. The 3-16-in. oxygen and acetylene hose are connected directly to the blowpipe, the usual screwed hose connections being dispensed with. Valves for adjustment of oxygen and acetylene pressure are placed on the handle in such a position that they can be operated by the thumb and forefinger of the hand holding the blowpipe, leaving the other hand free. The various welding heads are all designed for a constant oxygen pressure of 20 lbs per sq. in., making it possible for the welder to change the heads without changing the adjustment of the oxygen regulator.

This blowpipe weighs slightly over 9 oz. with the largest tip attached. The center of gravity lies near the middle of the blowpipe so that correct balance is maintained when the hose is attached. Although primarily designed for aircraft use this blowpipe is also well adapted to work of all kinds on light tubing or sheet metal.

METAL CUTTING ON A PRODUCTION BASIS

A new principaled Metal Cutting Saw has been developed by the DeWalt Products Corporation of Leole, Pa., known as the DeWalt "Wonder Metal Worker" for cutting seamless steel tubing and formed metal where a smooth, rapid cut is required.

The DeWalt "Wonder Metal Worker" is a 5 H. P. overhead direct drive, circular metal cutting saw which is adjustable to any angle, cutting tubing up to 3" in diameter, ⅛" wall thickness, making a clean, accurate cut in a fraction of the time formerly required. The DeWalt operates at 3600 RPM and the saw cuts as rapidly as it can be fed through the material.



New Metal Cutting Saw.

It was first developed to meet the needs of the Aeronautical Industry in making the many angle cuts necessary in the construction of the fuselage of the planes.

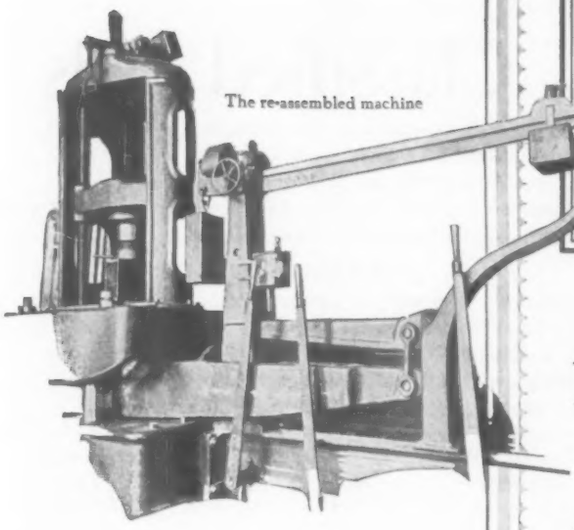
It is equipped with a 12" hollow ground metal cutting saw. This saw gives three to four days continuous operation in cutting ⅛" wall Molybdenum steel tubing before resharpening when it is touched up with an ordinary hand file. Eight to ten days is the usual service on low carbon steel before resharpening. A manual feed is provided for regular even pressure feeding of the saw through the material, producing a smooth cut for clean jointing.

Brass and bronze molding manufacturers are now using the DeWalt for making their miter cuts as well as windshield manufacturers and other manufacturers of formed metal products.

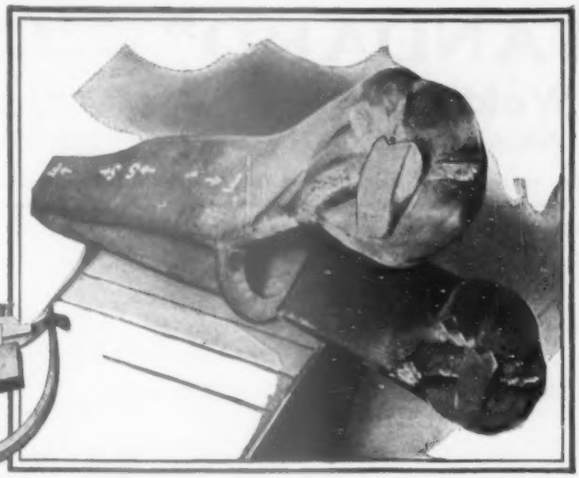
KINITE APPOINTS NEW DISTRIBUTORS

The Kinite Corporation, Milwaukee, Wis., have appointed the Bissett Steel Company, with offices at Cleveland, Cincinnati and Pittsburgh, and the H. Boker Company, Inc., New York and Boston, as distributors for Kinite Steel Alloy.

Kinite Steel Alloy is highly resistant to abrasion and compression—air hardening—and can be cast to any shape. It is used for dies, tools, machine parts and for reinforcing



The re-assembled machine



This lever arm Repair-welded with TOBIN BRONZE *in less than two hours*

The top portions of both sides of the lever arm of a testing machine in the University of Wisconsin laboratory were accidentally broken. Welding without dismantling and extensive preheating seemed an impossibility until the University authorities were advised that the fractured parts could be welded quickly and cheaply with Tobin Bronze.

The work was undertaken and the job successfully completed in less than two hours, whereas if the same work had been done with iron, much more time would have been required. That the welded lever is now as strong as ever, is indicated by the fact that upon several occasions it has been subjected to a pressure of 220,000 pounds, without showing signs of strain, and is giving as reliable service as at any time prior to the fracture.

For general welding of cast-iron by the oxy-acetylene process, use Tobin Bronze Rods, manufactured solely by The American Brass Company. Be sure the name "TOBIN BRONZE" [Reg. U. S. Pat. Off.] is stamped in the metal—then you may expect durable welds, tougher and stronger than the castings, without the necessity of extensive preheating.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities

ANACONDA
WELDING RODS

ANACONDA
from mine to consumer

There is a suitable Anaconda Filler Rod for every welding purpose. The principal Anaconda Welding Rods, with their melting points, are listed below:

for oxy-acetylene welding

Tobin Bronze	1625°F
Manganese Bronze	1598°F
Brazing Metal	1634°F
Deoxidized Copper	1981°F
Electrolytic Copper	1981°F
A. B. Naval	1625°F
Everdur	1866°F
Ambrac	2102°F

for arc welding

Phosphor Bronze	1922°F
Everdur	1866°F
Ambrac	2102°F
Deoxidized Copper	1981°F

"STANDARD"
Welding Wire
GAS AND ELECTRIC

for sound permanent welds : : lower costs
Our costs are considerably under those of large industrial centers; ours is a one-profit wire sold direct to user from our own mills exclusively devoted to making of welding wire from raw material to finished product—hence our extremely low prices for wire that is definitely superior. Adopted exclusively by many large users.
Prices on request.
A grade for each type of work—send for samples. Standard Steel & Wire Co., Greensburg, Pa. (Mills at Bolivar, Pa.)

wearing edges and faces by either electric or acetylene welding. It is supplied as castings and as barstock in standard sizes of flats, squares and rounds,—and as acetylene or electric welding rod.

G-E BULLETINS ANNOUNCE NEW ARC WELDERS

The General Electric Company of Schenectady, N. Y., has recently issued three new bulletins of interest to the welding public. Bulletin GEA-1031A describes their type AW resister arc welders, these being listed in three classes. One at 60 volts and 200 to 250 amperes, another at 200 to 275 volts and 60 to 200 amperes, and the third at 400 to 650 volts and 200 or 300 amperes. The latter two are equipped with trolley hooks to reach either trolley wire in mines or over electric railroads. Bulletin GEA-874C deals with their type WD-200A arc welder, which is constructed for either belt, motor, or gas-engine drive and is a self-excited, variable-voltage, single-operator machine. Its N. E. M. A. rating is 200 amperes, 1 hour, and with a current range of 60 to 300 amperes. Bulletin GEA-876B describes the type WD-400A arc welder, which is constructed for either belt or motor drive, and it too is a self-excited, variable-voltage, single-operator machine. Its N. E. M. A. rating is 400 amperes, 1 hour, and a current range of 100 to 500 amperes. Both of these latter two arc welders can be used as either stationary or portable machines.

INSULATED WELDING GAUNTLETS

Oxweld Acetylene Co., 30 E. 42nd St., New York City, has added to its line of accessories for oxy-acetylene welding and cutting, gauntlet gloves of a soft and pliable suede leather, specially treated to prevent heat from affecting it, to supersede the Oxweld horsehide gloves formerly supplied.

A leather strip on the thumb seam and a semi-circular reinforcement on the inside seam adjoining the palm reinforce the glove. The left glove has a leather reinforcement, covering the entire back between the fingers and gauntlet, for protecting the back of the left hand during cutting operations. A close fitting gauntlet adequately protects the arms. The reinforcements make them very durable. The manufacturers state that these gloves will not stiffen or shrivel from the application of heat or from soaking in water.

WELDING ROD HOLDER
FOR THE OXY ACETYLENE WELDER
$1.00
ALL STEEL WIRE BRUSHES
SEND $1.00 FOR 5 ASSORTED BRUSHES
Money refunded on return of goods, if not what you want.
WRITE FOR DEALERS' PRICES
C. SORENSEN, 18 E. 16th ST., CHICAGO

Classified Ads

Help Wanted—75c per line, minimum 4 line
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

CLASSIFIED ADS

Position Wanted—All-around oxy-acetylene welder with four years' experience in job shop work, five years foundry, one year on copper and brass. Prefer large foundry or aircraft plant. Will go anywhere. Address Box 171, care of The Welding Engineer.

Position Wanted—By man who is thoroughly experienced in all methods of welding, including supervisory and experimental work in large shops. Also experienced in service of welding equipment. Can furnish best of references as to character and ability. Willing to go anywhere. Available immediately. Address Box 172, care The Welding Engineer.

Wanted—Experienced man to sell electric and acetylene welding supplies in the Pittsburgh District. Williams & Co., Inc., 901 Pennsylvania Ave., N. S. Pittsburgh, Pa., Attention: Mr. E. C. Edmundson.

For Sale—One Wainwright Score Filling Machine. In first class condition. Allan Mfg. & Welding Co., Buffalo, N. Y.

Salesmen-Dealers—All territories. MASTER METAL ALUMINUM SOLDER—Clean and smooth; Tins easily; Bonds perfectly. For sheet and casting work in all trades working on Aluminum. It has toughness, strength and hardness. Works at 350 degrees. No flux used. Dept. AS-7, REYNOLDS METALS COMPANY, LOUISVILLE, KY.

Wanted—Thoroughly experienced welder for jobbing shop. Must be able to handle acetylene and electric welding of all kinds. Weiler Welding Co., 318 E. Second St., Dayton, Ohio.

One Dollar will increase your earning power by bringing you any one of the following GUARANTEED FLUX FORMULAS — Cast Iron — Brazing—Copper—Nickel—High Speed Steel—Aluminum (sheet and cast). With instructions you can make up your own fluxes fresh. R. N. Robbins, 38 Winans Street, East Orange, N. J.

Position Wanted—Experienced gas and electric welder with best of references. Desires to get lined up with contractor fabricating tanks and pipe lines and structural iron work with the Arc method. Address Box 173, care The Welding Engineer.

Seamless Steel Tubing
For All Purposes
Large stocks maintained at New York warehouse—549 W. 37th St.
Complete range of sizes.

EXCELD **Welding Wire**
Gas and Electric—Bare and Coated. Guaranteed free-flowing, absolutely uniform. Immediate delivery from New York and Pittsburgh stock.

Telephone:
Bowling Green 2570
E. D. GIBERSON & CO.
44 RECTOR ST.
NEW YORK

Pipe Cutting Simplified

Many of the patterns required for cutting pipe to make up welded fittings would take hours of time to develop in the drawing room.

Even the simplest patterns are difficult to make when one is not familiar with the principles of mechanical drawing.

Consequently, welded fittings may be costly to make, due to imperfect cutting.

As a solution of the cutting problem, we have for sale a complete set of full size blue prints of curves, which enable you to cut your connections *correctly and accurately* the *first* time.

THIS SET INCLUDES THE FOLLOWING CONNECTIONS:

PIPE PATTERNS

2" 3 Piece Ell
2" 45° Ell
2" Rt. Angle Ell
2" Lateral
2" Round End
2" Tee

3" 3 Piece Ell
3" 45° Ell
3" Rt. Angle Ell
3" Lateral
3" Round End
3" Tee
3" Y
3" Split Bull Plug

4" 3 Piece Ell
4" 45° Ell
4" Rt. Angle Ell
4" Lateral
4" Round End
4" Tee
4" Y
4" Split Bull Plug

6" 3 Piece Ell
6" 45° Ell
6" Rt. Angle Ell
6" Lateral
6" Round End
6" Tee
6" Y
6" Split Bull Plug

8" 3 Piece Ell
8" 45° Ell
8" Rt. Angle Ell
8" Lateral
8" Round End
8" Tee
8" Y
8" Split Bull Plug

10" 3 Piece Ell
10" 45° Ell
10" Rt. Angle Ell
10" Lateral
10" Round End
10" Tee
10" Y
10" Split Bull Plug

12" 3 Piece Ell
12" 45° Ell
12" Rt. Angle Ell
12" Lateral
12" Round End
12" Tee
12" Y
12" Split Bull Plug

4x3 Tee
6x3 Tee
6x4 Tee
8x6 Lateral
8x3 Tee
8x4 Tee

12x3 Swedge Nipples
12x4 Swedge Nipples
12x6 Swedge Nipples
12x8 Swedge Nipples
12x10 Swedge Nipples
10x3 Swedge Nipples
10x4 Swedge Nipples
10x6 Swedge Nipples
10x8 Swedge Nipples
8x6 Swedge Nipples
8x4 Swedge Nipples
8x3 Swedge Nipples
6x4 Swedge Nipples
6x3 Swedge Nipples
4x3 Swedge Nipples
3x2 Swedge Nipples

CASING PATTERNS

5 3/16" 3 Piece Ell
5 3/16" 45° Ell
5 3/16" Rt. Angle Ell
5 3/16" Lateral
5 3/16" Round End
5 3/16" Tee

6 5/8" 3 Piece Ell
6 5/8" 45° Ell
6 5/8" Lateral
6 5/8" Round End
6 5/8" Tee

8 1/4" 3 Piece Ell
8 1/4" 45° Ell
8 1/4" Lateral
8 1/4" Round End
8 1/4" Tee

ODD SIZE TEES

5 3/16Cx3" I. D. Tee
5 3/16Cx4" I. D. Tee
6 5/8Cx4" I. D. Tee
6 5/8Cx3" I. D. Tee

With these curves you can make patterns for any of the above on any desired material, without the use of mathematics or drawing instruments. They will save many times their cost.

Price $20.00

An Opportunity for Job Welders

These patterns will enable you to make up welded pipe fittings, which will be better and cheaper than cast fittings. This new and profitable line of business is a fine possibility in every locality.

The Welding Engineer

608 S. Dearborn Street
CHICAGO, ILLINOIS

You Can Do It Better With TORCHWELD

Production welding needs a torch of the proper size and balance to meet output requirements and Torchweld has the proper size torch for you.

No. 80NF	length,	8″	weight,	3 oz.
No. 90NF	″	10″	″	7 oz.
No. 30NF	″	11″	″	10 oz.
No. 31NF	″	11″	″	9 oz.
No. 40NF	″	11″	″	10 oz.
No. 41NF	″	11″	″	9 oz.
No. 1NF	″	12″	″	14 oz.
No. 21NF	″	15″	″	16 oz.
No. 22NF	″	14″	″	15 oz.
No. 2NF	″	15″	″	19 oz.
No. 3NF	″	18″	″	23 oz.
No. 4NF	″	20″	″	24 oz.
No. 6NF	″	24″	″	35 oz.

Every Torchweld Torch has built into it the exclusive Torchweld Patented Non-Flash Safety Features which eliminate Flash Backs.

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Adaptability

use

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Write for Catalog No. 28.

TORCHWELD EQUIPMENT COMPANY
224 N. Carpenter St. CHICAGO

---*for* Strong welds

Nichrome

TRADE MARK REG. U. S. PAT. OFF

---*the exceptionally strong* Welding Rod

Welds made with "Nichrome" the nickel-chromium alloy, possess exceptional strength. For example, practical tests of welds on mild steel made with "Nichrome" rods, show an ultimate tensile strength as high as 55,000 pounds per square inch. It is interesting to note that the welding operation does not detract from the metal itself.

"Nichrome" welds are readily machinable and may be applied by either the oxy-acetylene or arc welding process. The ease of application and free flowing qualities of "Nichrome" welding rod, together with the fact that it can find wide application, makes its use extremely desirable.

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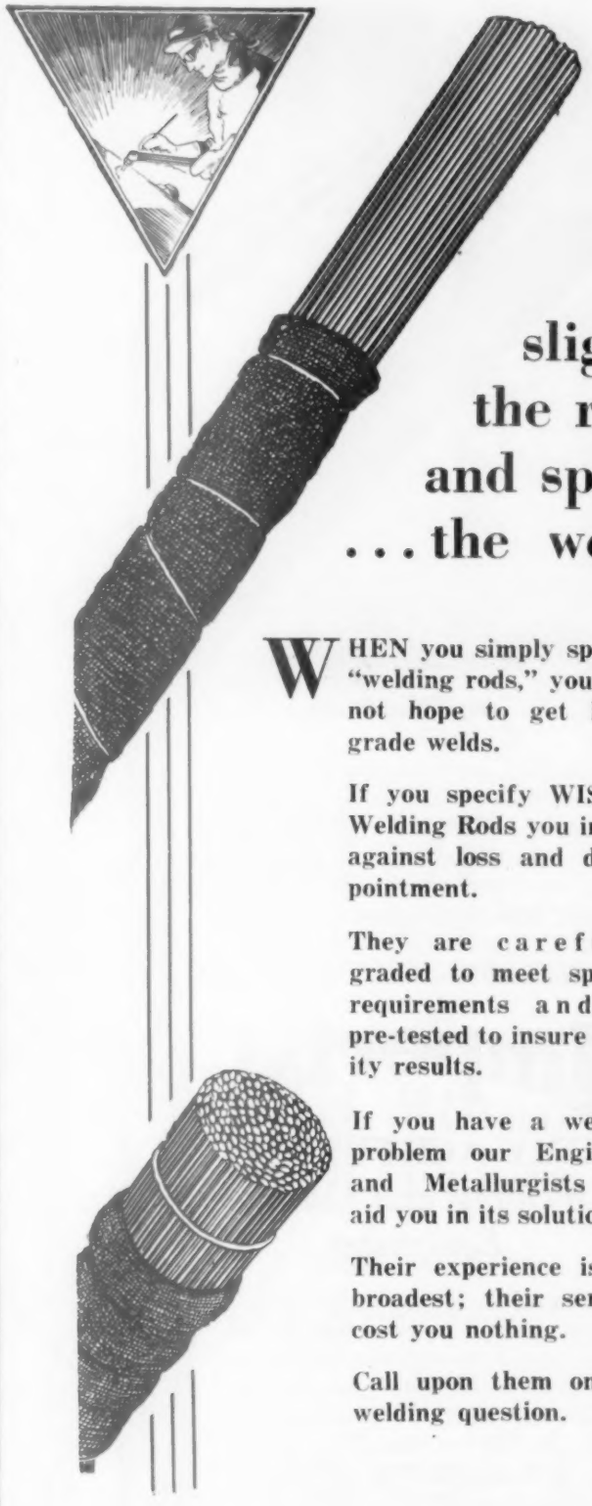

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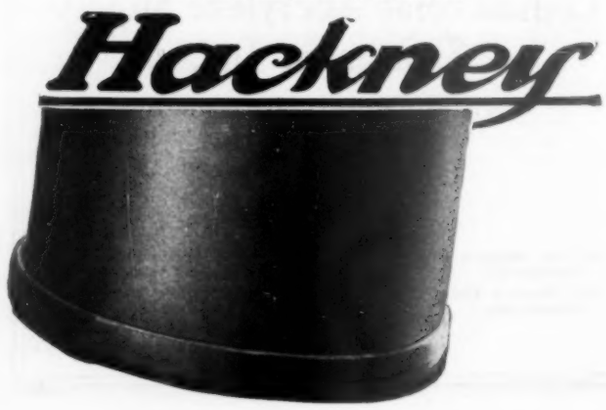

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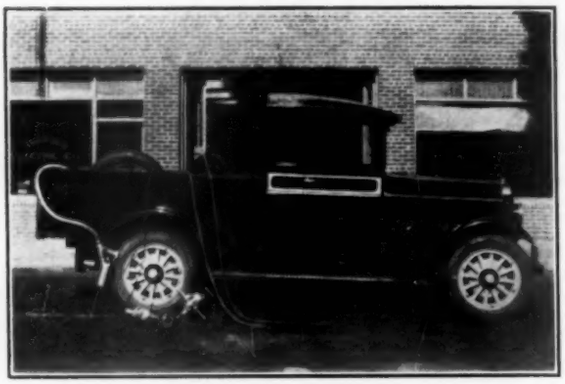

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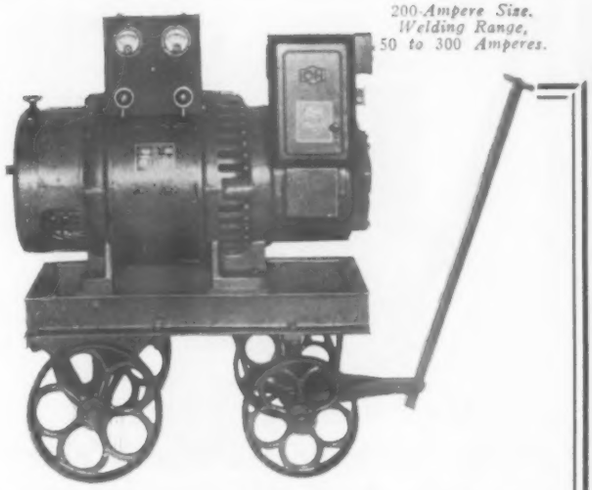

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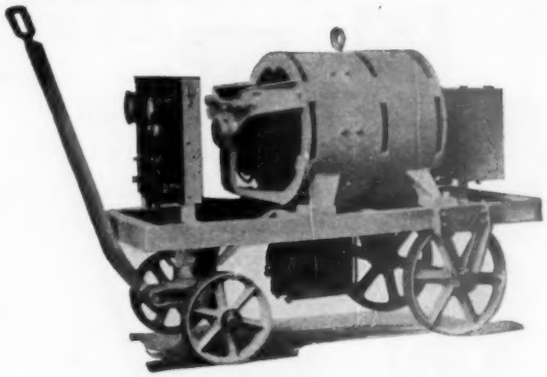

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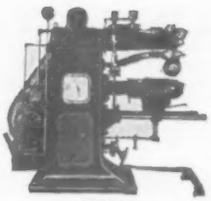

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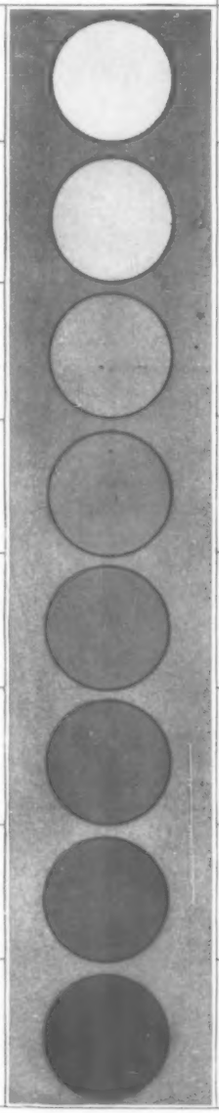
Shade No. 2		2.7 *per cent*	.5 *of one per cent*	40.3 *per cent*	Heating furnaces, welding observation, lead burning and other work involving low temperatures
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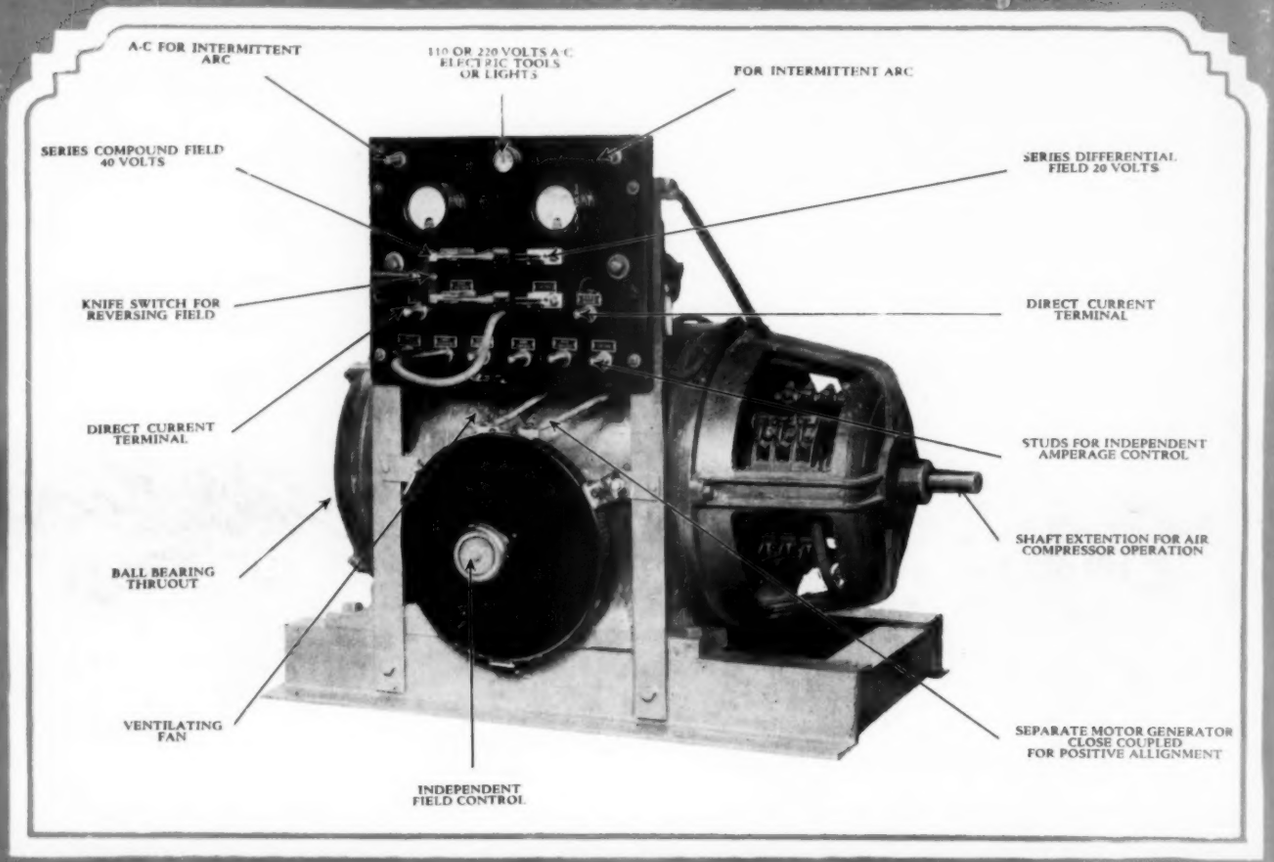
Shade No. 5		.05 *of one per cent*	.00 *per cent*	1.7 *per cent*	For acetylene cutting and welding
Shade No. 6		.00 *per cent*	.00 *per cent*	1.1 *per cent*	Most widely used shade for general maintenance work at acetylene welding and cutting operations
Shade No. 8		.00 *per cent*	.00 *per cent*	.16 *of one per cent*	For heavy acetylene welding and for electric welding up to 20 amperes. Also carbon arc observation
Shade No. 10		.00 *per cent*	.00 *per cent*	.028 *of one per cent*	For electric arc welding operations up to 200 amperes
Shade No. 12		.00 *per cent*	.00 *per cent*	.005 *of one per cent*	For electric arc welding operations over 200 amperes, also atomic hydrogen welding

WILLSON PRODUCTS, Inc.

READING, PENNSYLVANIA

U. S. A.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110 OR 220 VOLTS A.C. ELECTRIC TOOLS OR LIGHTS
FOR INTERMITTENT ARC
SERIES COMPOUND FIELD 40 VOLTS
SERIES DIFFERENTIAL FIELD 20 VOLTS
KNIFE SWITCH FOR REVERSING FIELD
DIRECT CURRENT TERMINAL
DIRECT CURRENT TERMINAL
STUDS FOR INDEPENDENT AMPERAGE CONTROL
SHAFT EXTENTION FOR AIR COMPRESSOR OPERATION
BALL BEARING THRUOUT
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SEPARATE MOTOR GENERATOR CLOSE COUPLED FOR POSITIVE ALLIGNMENT
INDEPENDENT FIELD CONTROL

A Welding Generator with

THESE EIGHT ADVANTAGES

is the welder that vanquishes every job

Dualarc is the ONLY generator providing A. C. for the semi-arc flash welding process so popular in the automotive trade

THE "DUALARC"

1. Will operate as either a compound or differentially wound generator, giving maximum efficiency with either the metallic or carbon arc.
2. Has independent control of voltage and amperage, providing widest range of flexibility and heat control.
3. Can be equipped with slip rings to provide alternating current supply for the operating of electric drills, grinders and drop lights, in addition to intermittent (flash) welding as used for repairing scored cylinders. An exclusive patented feature.
4. It is equipped with interpoles insuring steady commutation and greater stability of current.
5. It is self-excited. No separate exciter is necessary. This reduces maintenance costs and also provides better current characteristics.
6. It is impossible to overload the machine as the windings are so arranged that in case of an overload the machine is short circuited causing the voltage to die away to a low value although maintaining the maximum current constant. This short circuiting does not injure the generator.
7. It is equipped with an efficient reactor of the open-circuit, open core type which adjusts itself progressively to current requirements.
8. Ball bearings throughout, reducing maintenance cost and attention.

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